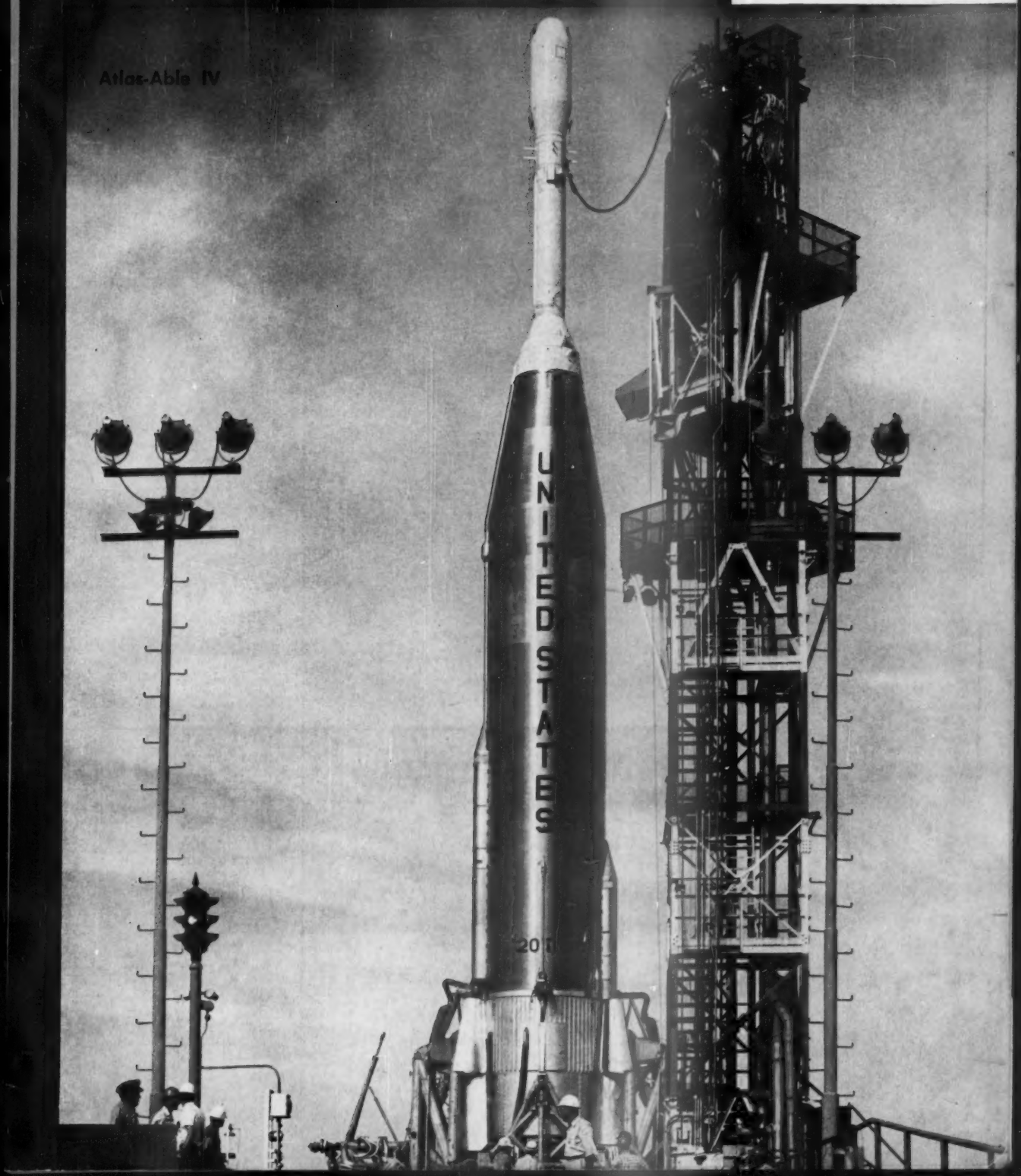
December 7, 1959

Aviation Week

Including Space Technology

USAF Pushes Minuteman Silo Test Shots



Let's get him there first!

A complete line of *Kaylock*® "Spaceweight" fasteners is available now for aerospace vehicles, electronics, engines.

FOR COMPETITIVE REASONS, reappraise your projects with an eye to "trimming off the fat." Send today for Kaynar's new full-line brochure of 160,000 psi. self-locking nuts.

H14 6-point Hex Nut

MF1400 Miniature Floating Anchor Nut

K2400 1-Lug Anchor Nut

MK1400 Miniature 2-Lug Anchor Nut

F2400 1-Lug Floating Anchor Nut

F5400 2-Lug Floating Anchor Nut

K1400 2-Lug Anchor Nut

MK4400 Miniature Short Lug Anchor Nut

G1400 Narrow Gang Channel

K3400 Corner Anchor Nut

MK2400 Miniature 1-Lug Anchor Nut

MK3400 Miniature Corner Anchor Nut

RG1231 Radius Gang Channel

H23 12-Point High Tensile Nut

H20 12-Point High Tensile Nut

H24 12-Point High Tensile Nut

H10 6-point Hex Nut

TENSILE STRENGTH
H10 meets requirements of MIL-N-25027, AN-N-5 and AN-N-10 (NAS679) (AN363, 364, 365) (MS21041) for use on 125,000psi. bolts and screws.

PART NO.	SERVICE TEMP.	TENSILE STRENGTH	MATERIAL
H14	550°F.	160,000psi.	Carbon Steel
MF1400	550°F.	160,000psi.	Carbon Steel
K2400	550°F.	160,000psi.	Carbon Steel
MK1400	550°F.	160,000psi.	Carbon Steel
F2400	550°F.	160,000psi.	Carbon Steel
F5400	550°F.	160,000psi.	Carbon Steel
K1400	550°F.	160,000psi.	Carbon Steel
MK4400	550°F.	160,000psi.	Carbon Steel
G1400	250°F.	160,000psi.	Nuts-Carb. Stl. Channel-Alum. Alloy
K3400	550°F.	160,000psi.	Carbon Steel
MK2400	550°F.	160,000psi.	Carbon Steel
MK3400	550°F.	160,000psi.	Carbon Steel
RG1231	1,200°F.	160,000psi.	Nuts-A286 CRES. Channel-321 CRES.
H23	550°F.	180,000psi.	Alloy Steel
H20	550°F.	180,000psi.	Alloy Steel
H24	550°F.	220,000psi.	Alloy Steel
H10	550°F.	125,000psi.	Carbon Steel

All configurations shown are available in A286 Stainless Steel for high temperature applications.

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NOW AVAILABLE IN STANDARD FLAT PANELS

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AVAILABLE TOO *IN Semi-Standard Panels* which offer a wider selection of face materials and over-all thickness; *IN New "Type-Z" Panels* for weight-savings of 50% over solid materials—can be riveted or bolted just like solid sheet aluminum!

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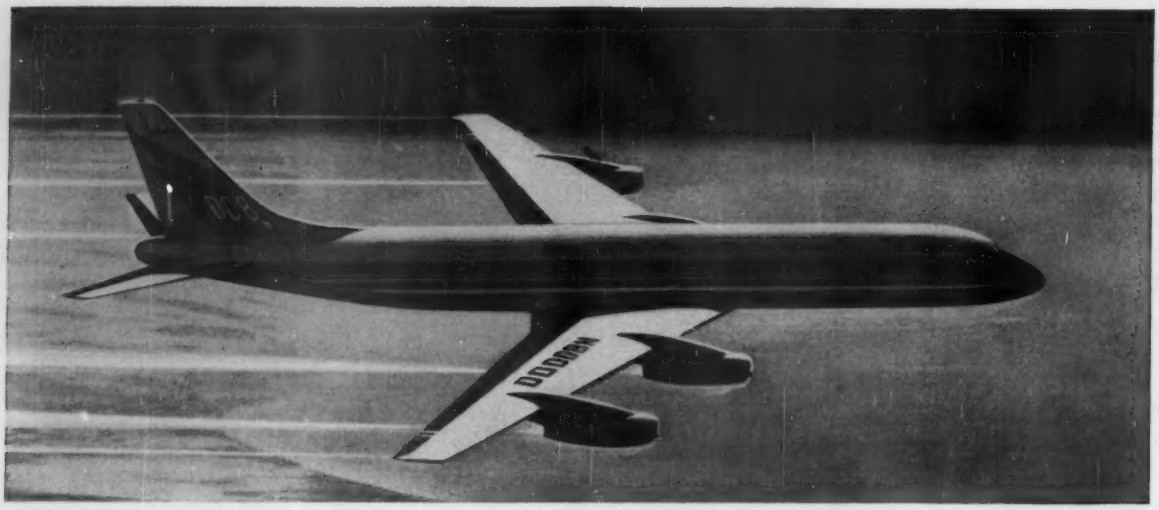

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A semi-flexible cable with tubular copper inner conductor, foamed polyethylene dielectric and commercially pure aluminum outer conductor.

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1. Twice the efficiency of solid dielectric (RG-8A/U) type of cable now in general use.
2. Extended life characteristics that permit permanent installation and assure electrical stability during the life of the plane.
3. Good frequency response over wide temperature variations; capable of withstanding highest summer ground temperatures, as well as extremely low temperatures found at high altitudes.
4. Greater efficiency and improved system performance without the use of additional electronic components.
5. Ability to operate in both pressurized and non-pressurized parts of a plane without the use of cable dehydrators or pressurizing systems.
6. Lighter and smaller than many cables now installed in aircraft.

Foamflex coaxial cable is supplied in long lengths on lightweight, disposable reels. For further information or inquiries, write Dept. FC.

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AVIATION CALENDAR

Dec. 16—Army Aviation Contract Services Symposium, Mayflower Hotel, Washington, D. C. Sponsor: Aeronautical Training Society.

Dec. 17—23rd Wright Brothers Lecture, Natural History Bldg., Smithsonian Institution, Washington, D. C. Dr. Alexander H. Flax, chief Air Force scientist, will speak on "High Temperatures in Hypersonic Flow—Physical Principles and Experimental Techniques." Dr. Flax will repeat his lecture on Dec. 18 before the IAS Cleveland Section, on Dec. 21 before the IAS Los Angeles Section, and Dec. 22 before the IAS Texas Section.

Dec. 26-30—Sixth King Orange International Model Plane Meet, Miami, Fla.

Dec. 26-31—Annual Meeting, American Assn. for the Advancement of Science, Morrison Hotel, Chicago, Ill.

Jan. 11-13—Sixth National Symposium on Reliability and Quality Control in Electronics, Statler-Hilton Hotel, Washington, D. C.

Jan. 12-16—16th Annual Technical Conference, Society of Plastics Engineers, Conrad Hilton Hotel, Chicago, Ill.

Jan. 18-21—Sixth Annual Meeting American Astronautical Meeting, Statler-Hilton Hotel, New York, N. Y.

Jan. 25-28—28th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 26.

Jan. 28-29—Solid Propellants Conference, American Rocket Society, Princeton University, Princeton, N. J.

Feb. 1-4—Winter Conference & Exhibit, Instrument Society of America, Rice Hotel and Sam Houston Coliseum, Houston, Tex.

Feb. 3-4—Sixth Annual Midwest Welding Conference, Illinois Tech Chemistry Bldg., Chicago, Ill. Sponsors: Armour Research Foundation of Illinois Institute

(Continued on page 6)

AVIATION WEEK Including Space Technology

December 7, 1959

Vol. 71, No. 23

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These liquid cooling systems are completely self-contained—provide such components as pumps, heat exchangers, air impellers, reservoir, coolant flow and temperature interlocks and similar parts.

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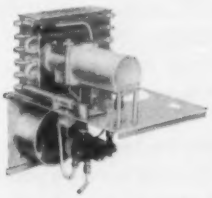
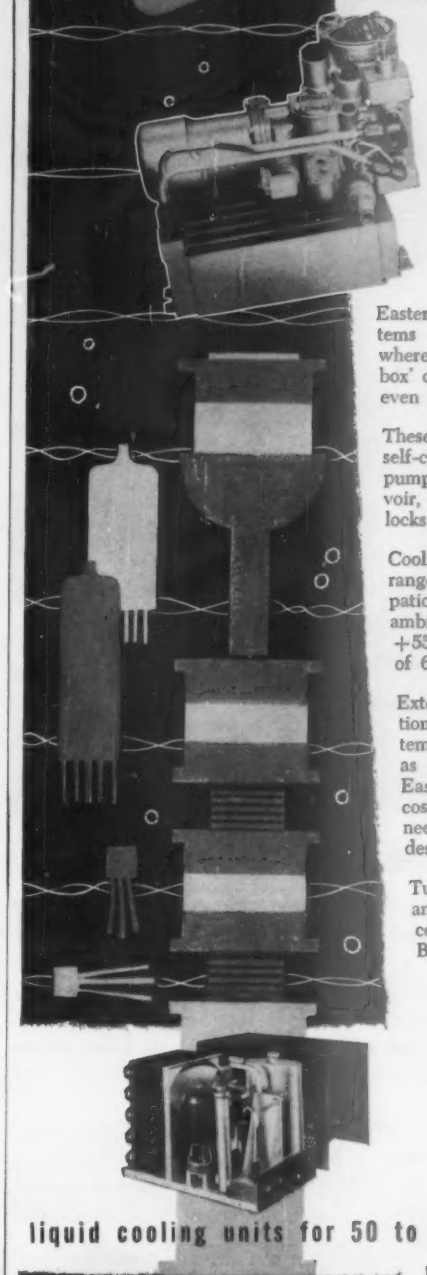
Turn to Eastern for space-, weight-, and cost-saving solutions to your hottest cooling problem. Write for New BULLETIN 360.





liquid cooling units for 50 to 50,000 watts dissipation

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AVIATION CALENDAR

(*Continued from page 5*)

of Technology; Chicago Section, American Welding Society.

Feb. 3-5—1960 Winter Convention on Military Electronics, Institute of Radio Engineers, Biltmore Hotel, Los Angeles.

Feb. 10-12—Seventh Annual Solid-State Circuits Conference, Philadelphia, Pa. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; University of Pennsylvania.

Feb. 16-18—First National Symposium on Nondestructive Testing of Aircraft and Missile Components, Hilton Hotel, San Antonio, Tex. Sponsors: Southwest Section, Society for Nondestructive Testing; Southwest Research Institute.

Mar. 10-11—National Flight Propulsion Meeting (classified), Institute of the Aeronautical Sciences, Cleveland, Ohio.

Mar. 23-25—Symposium on Optical Spectrometric Measurement of High Temperatures, University of Chicago, Chicago, Ill. Sponsors: University of Chicago's Applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation.

Apr. 6-8—Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif. Sponsor: American Rocket Society's Structures and Materials Committee.

Apr. 6-8—1960 National Meeting "Hyper-Environments—Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, Calif.

Apr. 19-21—International Symposium on Active Networks and Feedback Systems, Engineering Societies Bldg., New York, N. Y. Sponsors: Polytechnic Institute of Brooklyn; Department of Defense Research Agencies; Institute of Radio Engineers.

Apr. 20-22 — National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: National Aeronautics and Space Administration; the Rand Corp.

Apr. 21-22—Southwest Metals & Minerals Conference "Metals and Materials for the Space Age," American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

Apr. 25-29—41st Annual Convention and Exposition, American Welding Society, Biltmore Hotel and Great Western Exhibit Center, Los Angeles, Calif.

Apr. 27-28—National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.

May 9-11—1960 Symposium of the Institute of Radio Engineers' Professional Group on Microwave Theory and Techniques, Hotel del Coronado, San Diego, Calif.

May 9-13—Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton Dallas Hotel and State Fair Park, Dallas, Tex.

May 10-12—1960 Electronic Components Conference, Willard Hotel, Washington, D. C. Sponsors: Institute of Radio Engineers' Professional Group on Component Parts; American Institute of Electrical Engineers; Electronic Industries Assn.; Western Electronic Manufacturers Assn.

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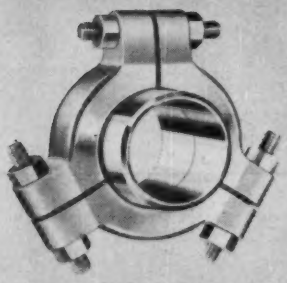
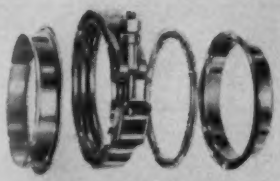
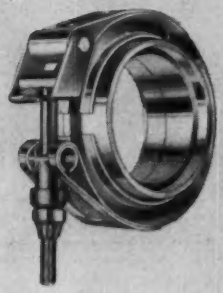


CONOSEAL PIPE JOINT

J-13 JOINT



J-11 JOINT



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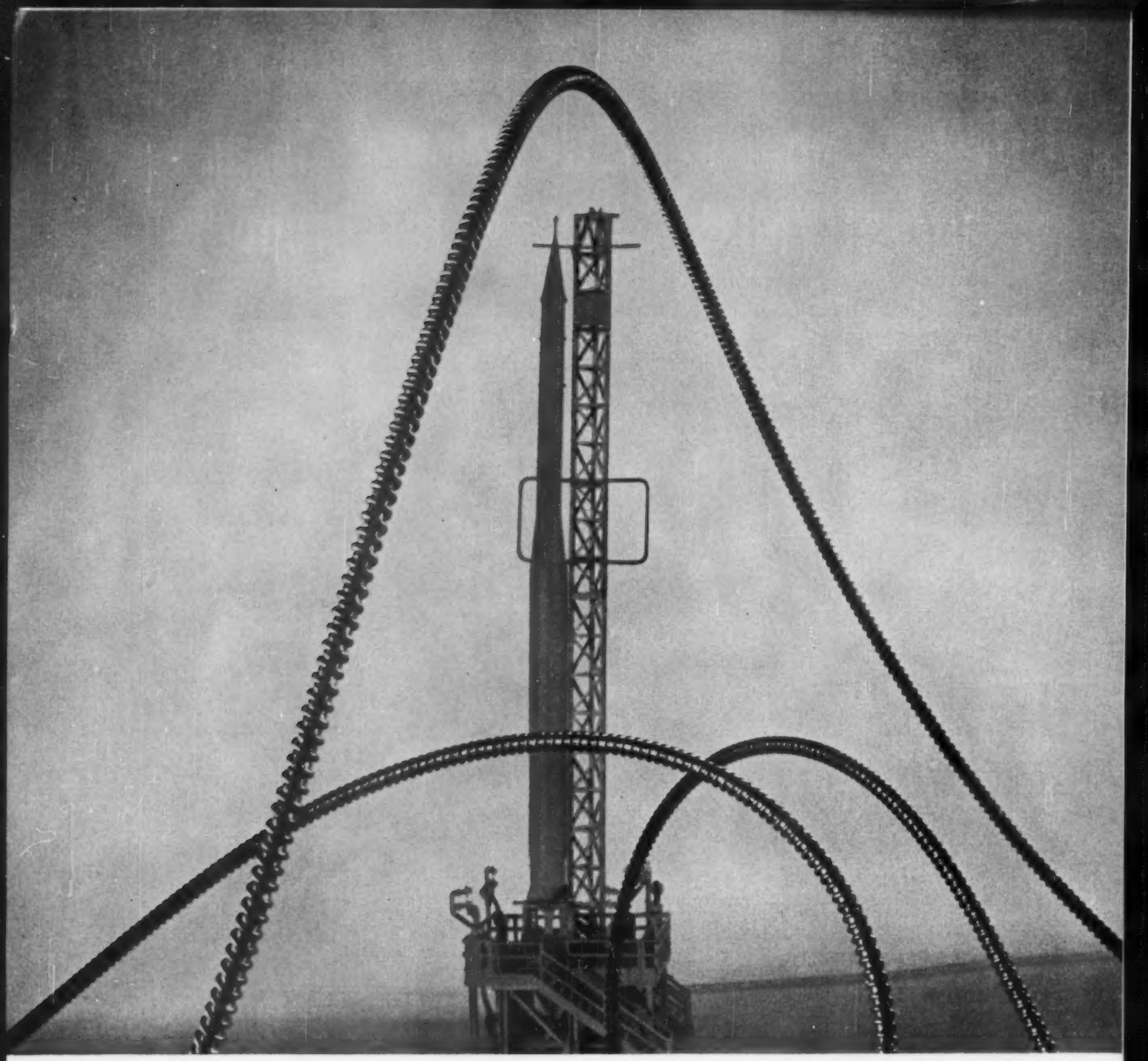

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unlimited rotary

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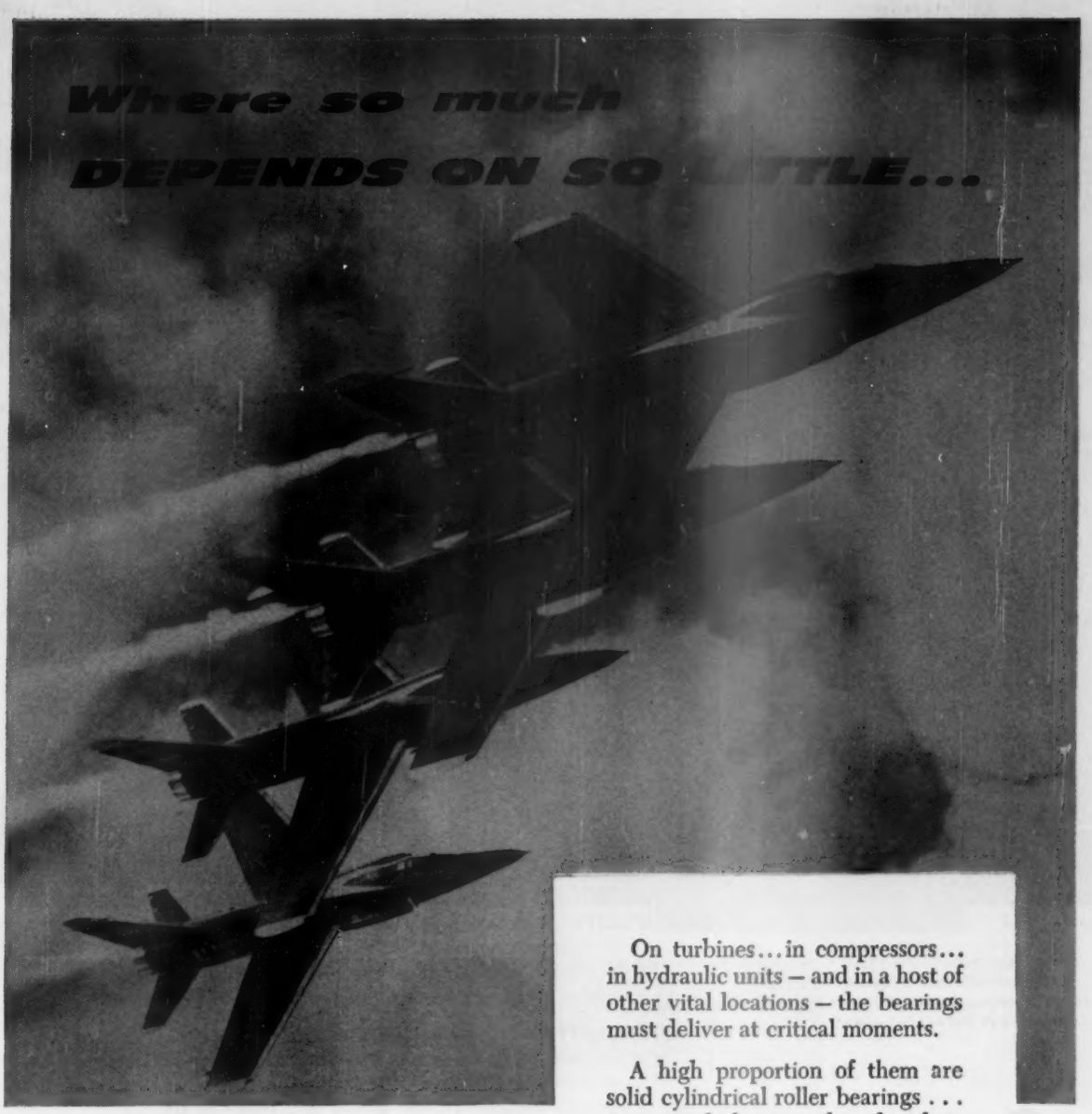

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Sikorsky S-64 —new 8-ton payload turbine-powered flying crane

HIGH CAPACITY—With an 8-ton payload, Sikorsky's new S-64 turbine-powered crane, will carry *three tons more* than the experimental S-60. It is the first in a new family of Sikorsky turbocranes designed to carry up to *40 tons*.

TOP VERSATILITY—In restricted areas where even a helicopter cannot land, the S-64 is designed to raise and lower loads on a hoist, as above. Where landings are possible, cargo can be attached by cable to four hard points on the fuselage. The S-64 is designed to straddle bulky loads nine feet high and almost 20 feet wide. A variety of passenger and cargo pods, bins and platforms, plus almost vibration-free suspension will make the S-64 a Universal Transport Vehicle of unprecedented versatility and usefulness for military or commercial service.

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FIRST FLIGHT—The first S-64 is programmed for flight in the fall of 1960.

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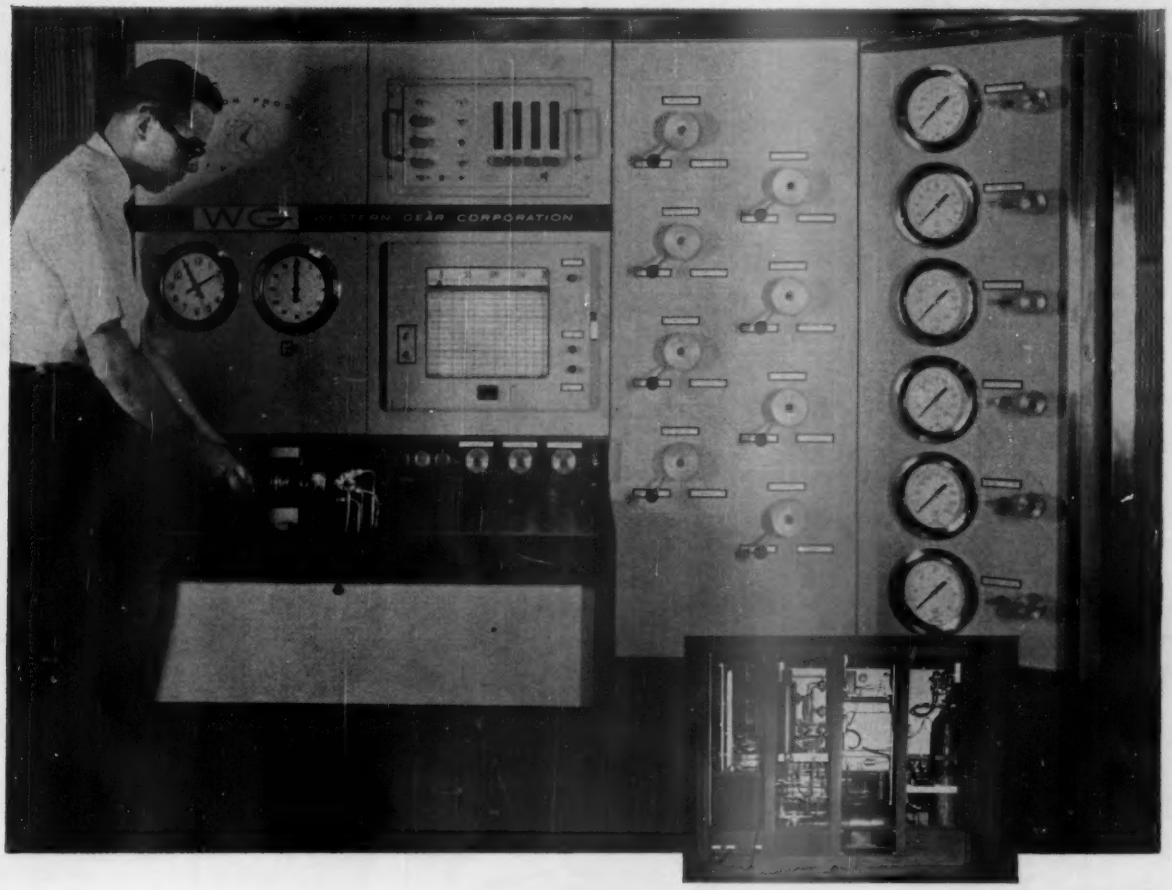
Three system test stand console designed by Western Gear for field servicing of Convair F-106 Vari-Duct Drive unit. Fourteen individual performance tests guarantee reliability. High pressure hydraulic test at 4500 psi, low pressure at 300 psi, pneumatic emergency test at 2500 psi. Features built-in include safety precautions to prevent unit damage during test and calibration. Performs static, operational, load, stall and running tests, includes counter and recorder. Stainless steel piping throughout.



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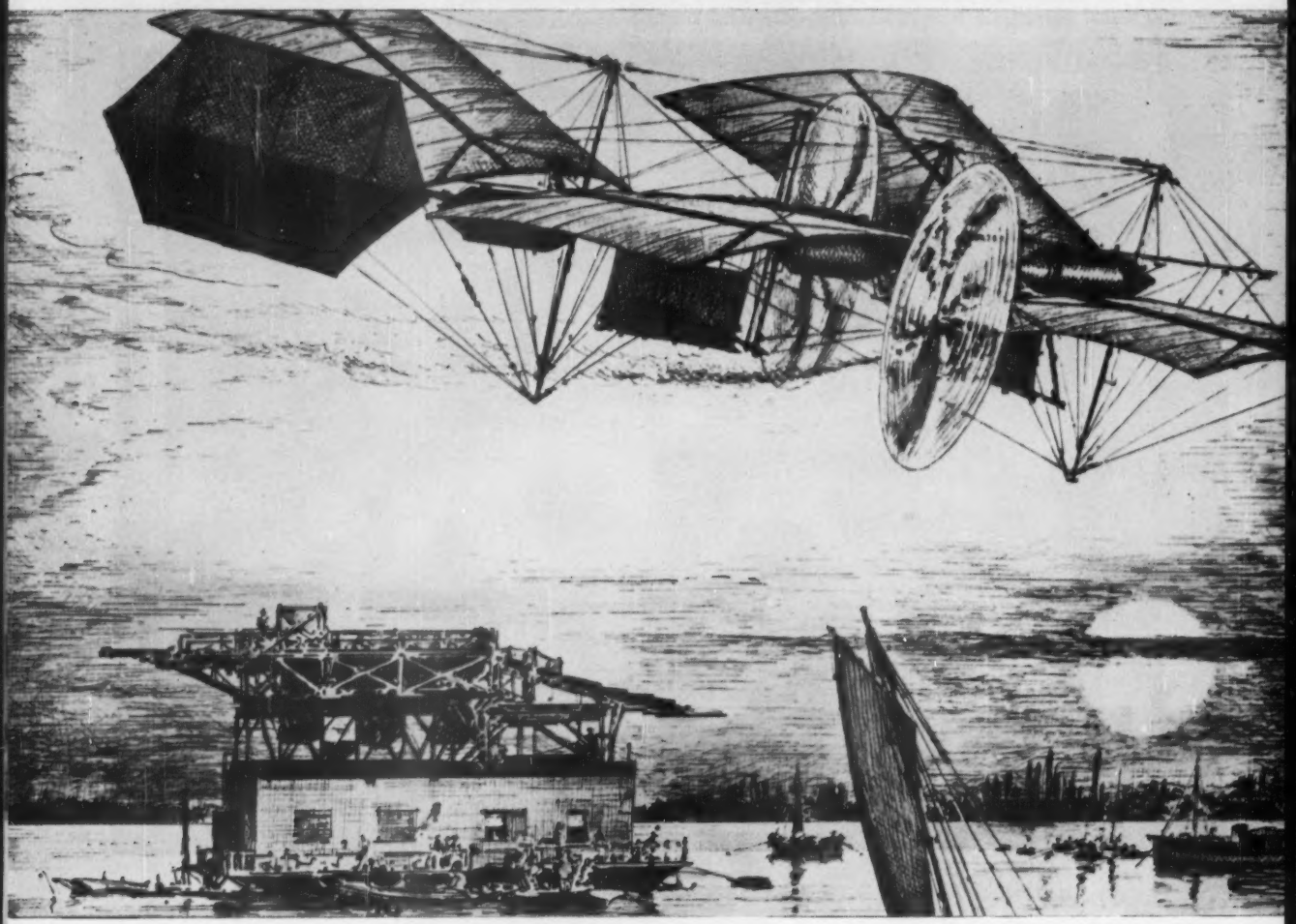
Propulsion through the ages . . .



Full-scale "aerodrome" design of Prof. Samuel P. Langley, 1903

An outstanding proposal : in 1903, dawn of the air age, Professor Samuel P. Langley, then Secretary of the Smithsonian Institution, dreamed of this triumphant scene, and with good reason. Models of his " aerodrome " had successfully flown over the Potomac. Langley was the first of the pioneers with lightweight power at his disposal — a 54 h.p. engine turned two pusher propellers. Two attempts were made to fly the full-scale machine from the anchored houseboat, in October and again in December 8, 1903. Each time it plunged into the river. An official report cited the launching catapult as cause of the failures. Nine days later the Wright brothers flew . Today, near the banks of the Potomac, Rotol, the world's most experienced manufacturer of turbo-propellers, maintains its American subsidiary, Rotol Incorporated, for after sales service on turbo-props in North and Central American and Caribbean service. Over 100 airline and aircraft operators throughout the world attest to the reliability of Rotol turbo-props, standard equipment on the Vickers Viscount, Fairchild F-27, Grumman Gulfstream, and Fairey Rotodyne.

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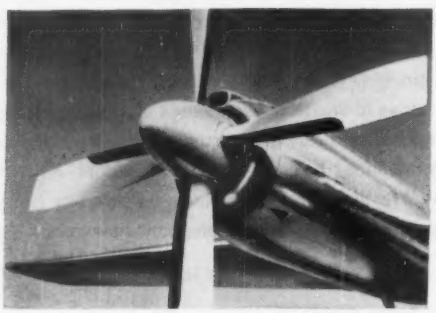
The world's most experienced manufacturers of turbo-propellers — over 6,000,000 hours of flying time.



Rotol Incorporated after-sales service throughout the United States provides immediate spare parts delivery, technical service on propeller operations and applications.

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This is an actual photograph of 1½" Springfield "400" hose.

NOW!

design with large diameter Teflon* hose that bends like this!

6¾"

If you design fluid handling, transfer, or hydraulic equipment, you already know Teflon hose. Wonderful! Except, up to this time larger diameters were not really flexible. But *now* look!

SPRINGFIELD "400" WITH FINGER FLEXIBILITY ONLY TITEFLEX HAS IT!**

- Minimum bend radius: *only 3⅓ times the hose diameter!* Thanks to the exclusive TITEFLEX process.
- Teflon innercore with all its properties. It's tough, lightweight, inert, resistant to corrosion and temperature extremes. Flex life is almost endless.
- Available now up to 2" in diameter, lengths to 25 feet (soon to 50!).
- Fittings prove failure-proof—right up to burst pressure of hose!
- In many cases, a shorter Springfield "400" hose can replace extruded hose at big savings.

Springfield "400" has already made exciting news in scores of applications—new uses crop up every day. How about your field? Our bulletin will set design ideas clicking. Get a copy by dropping us a line direct.

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Do these Springfield "400" applications suggest anything to you?

TANK, CAR, BARGE, MILITARY VEHICLE application • CHEMICAL • HIGH TEMPERATURE AIR • PLASTIC COMPOUND • HOT TAR AND ASPHALT • LIVE STEAM • CORROSIVE FLUID • HIGH TEMPERATURE HYDRAULIC SYSTEMS • AIRCRAFT: high temperature fuel and lubricating systems • MISSILE: fuel and oxidizer lines of vehicles and ground support •

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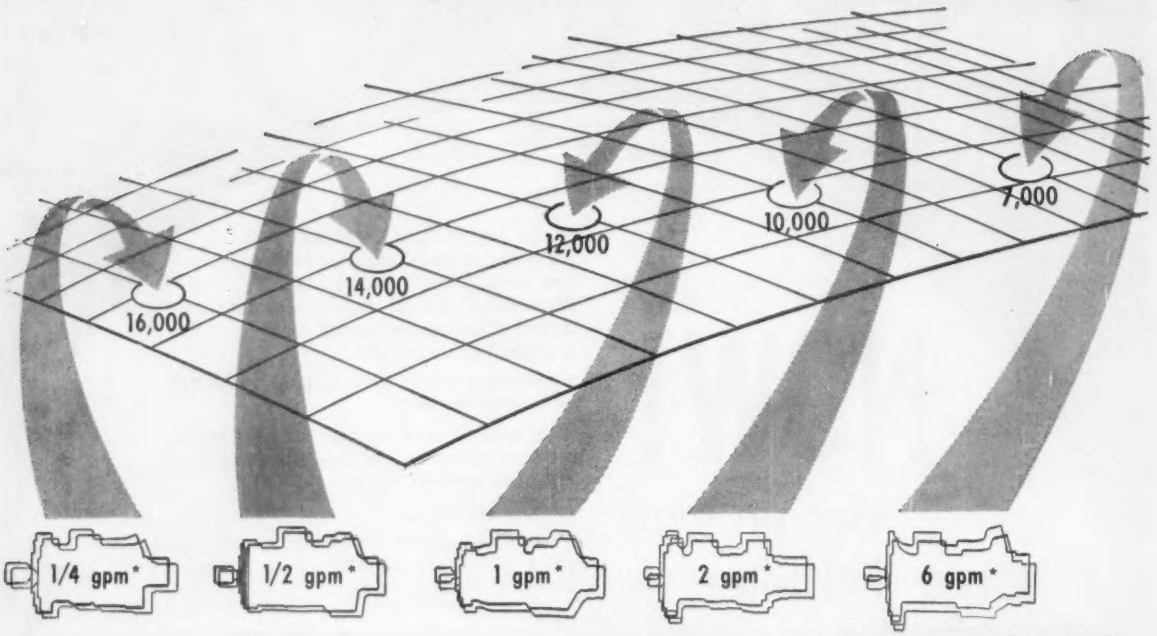

* Rated at 1500 rpm

These are what we've been calling "high speed" pumps.

But even "regular" models far surpass accepted speed standards

We used to distinguish "high speed" and "regular", BUT...

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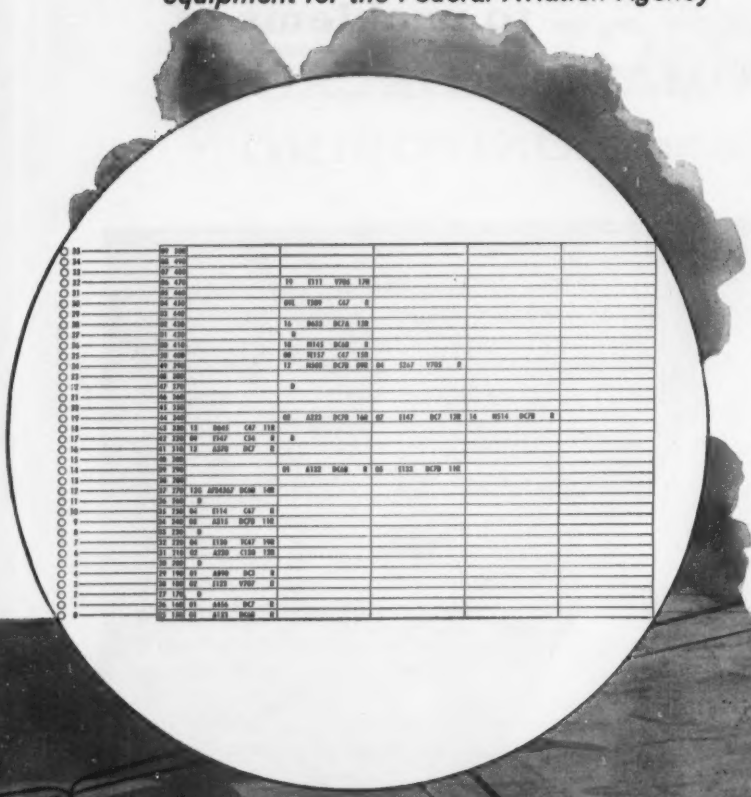

GPL's contracts for the FAA's experimental data processing central—the heart of tomorrow's air traffic control system—point up the diverse talents required of an effective systems manager.

As prime contractor for this FAA Bureau of Research and Development project, GPL contributes to the design and assumes responsibility for direction, schedules, plans, budgets, and the performances of nine associated companies. Necessary technical capabilities include broad knowledge of air traffic control problems, computers, data handling, radar, communications, human engineering, and "systems thinking" capable of integrating these varied disciplines into a practical, workable system.

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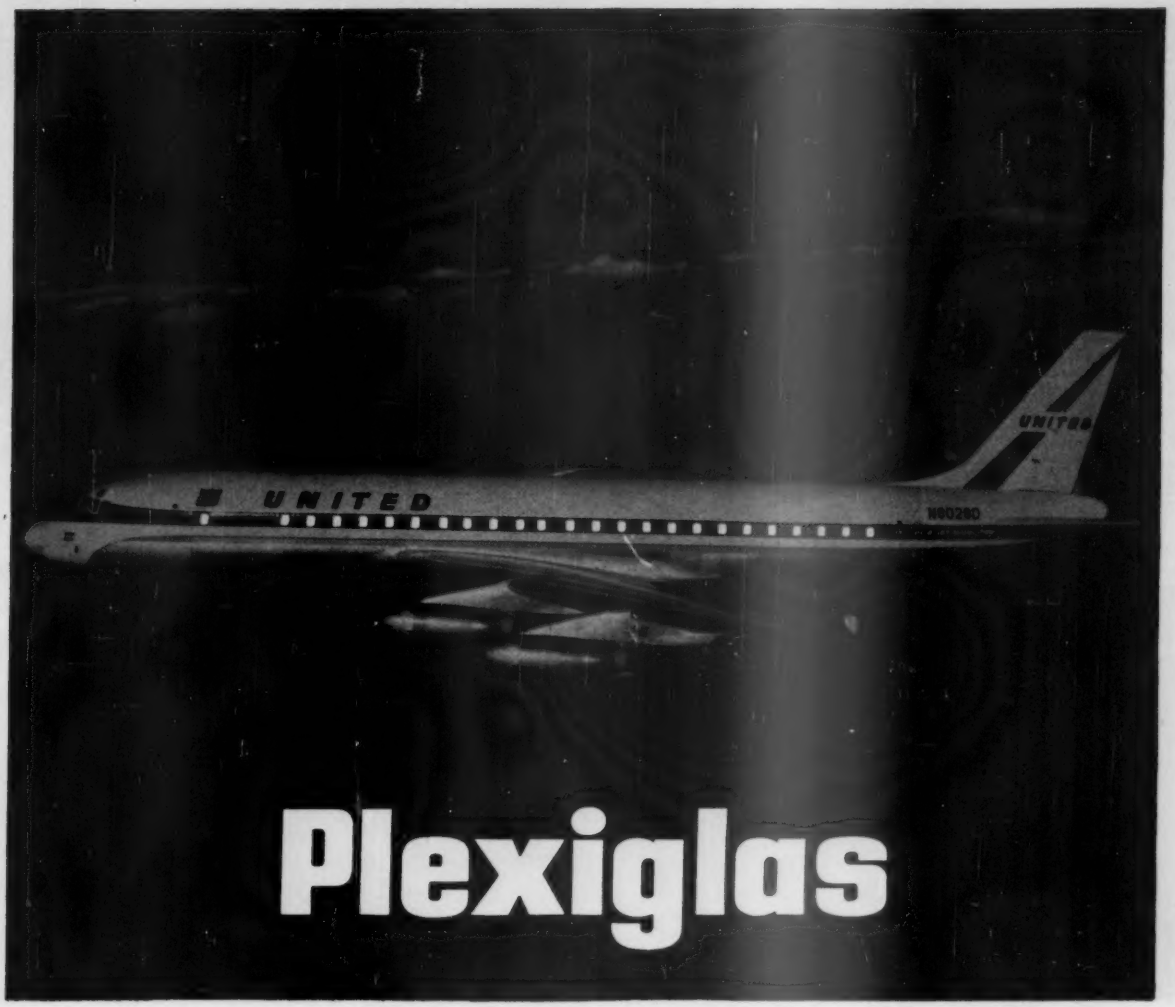

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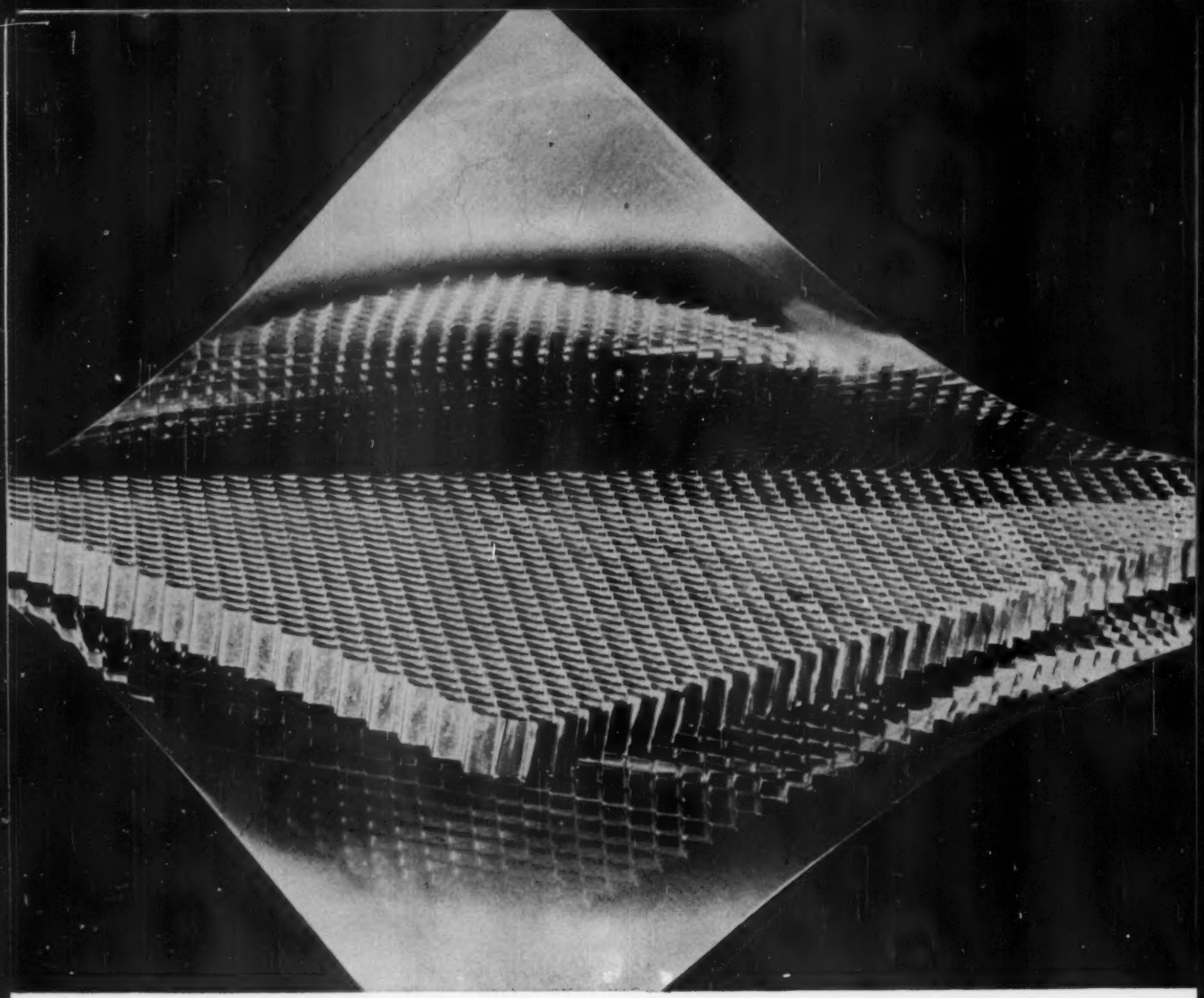

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▶ Major subsystems eliminated, flight date delayed; North American will recall airframe subcontracts.

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▶ Airlines foresee one-third increase in seat capacity next season, as 12 carriers phase jets into service.

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▶ USAF pushes firings of full-scale solid propellant Minuteman model to lay groundwork for advanced testing.

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COVER: Attempt to put the heaviest scientific payload yet launched by the U. S. into an orbit around the moon failed Nov. 26. Glass fiber fairing surrounding the 372 lb. paddlewheel satellite apparently fell off prematurely some 45 sec. after the 98-ft. Atlas-Able was launched at Cape Canaveral, Fla. Payload and possibly the upper portion of the vehicle tore loose and payload parts were found near the Cape. Another Atlas-Able exploded on the launching pad after a static test in September. Backup payload exists but no other Atlas-Ables have been ordered (see story on p. 31; pictures on pp. 52-53).

PICTURE CREDITS

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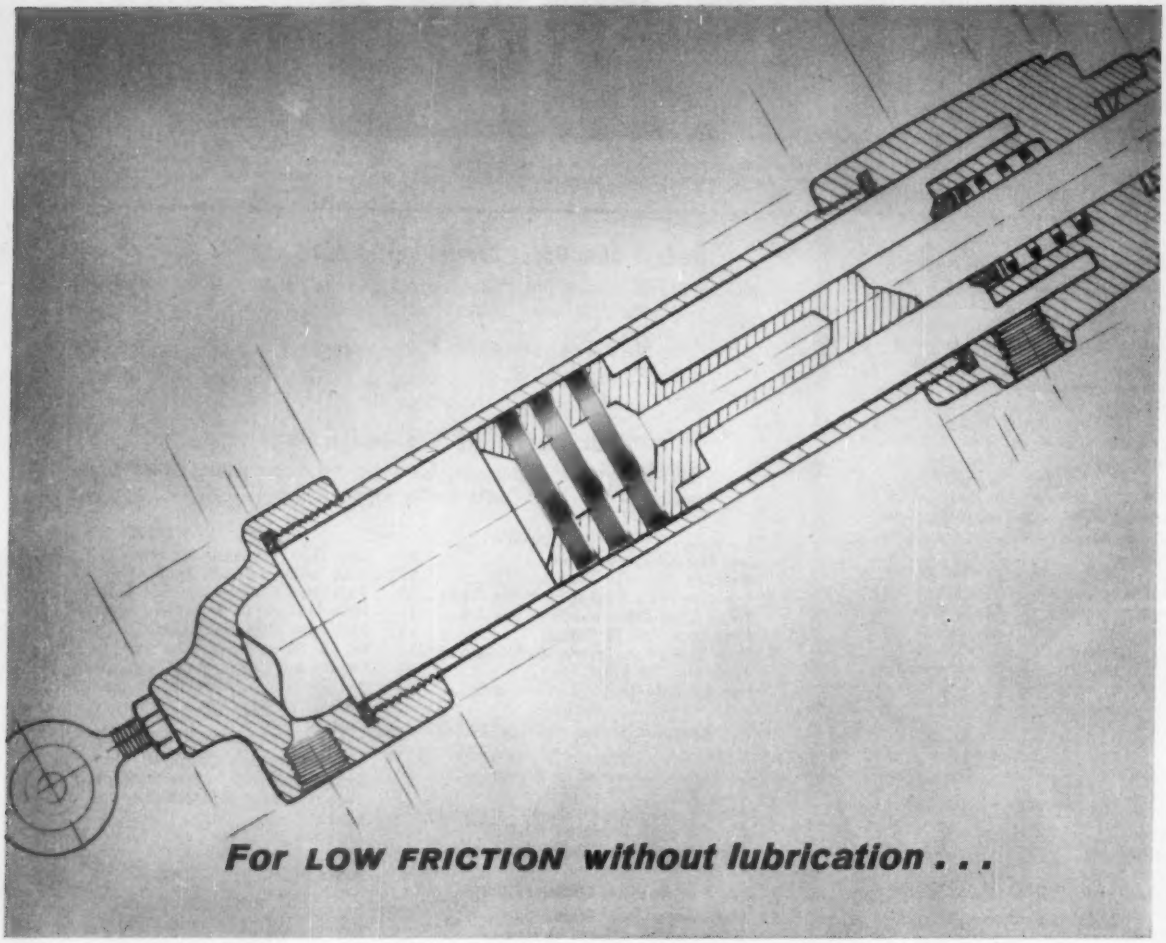

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EDITORIAL

A Dangerous Decision

The decision to cut the B-70 Mach 3 bomber development program to a bare skeleton (see p. 26) is one of the most dangerous decisions made in this country during the past decade. It is comparable in character and magnitude of error to the historic post-war British decision to abandon the pursuit of supersonic flight with manned research vehicles—a blow from which British aviation has not yet recovered.

The B-70 development program represents considerably more than any possible economic effect on North American Aviation, Inc., the prime contractor, or its myriad of subsystem developers and subcontractors scattered throughout the country.

In its essence, the B-70 program is the spearhead of the research effort whose goal is the development of the next significant generation of aircraft—both military and civil—which happens to be in the Mach 3 area. It also represents the effort to preserve a basic vital element in any future aerial war, whether fought with missiles, manned vehicles or both.

This is the ability to penetrate any enemy's territory and return safely. Without this ability even the strongest missile capability is subjected to severe limitations in its potential effectiveness. The ability to penetrate successfully and return is necessary even for the effective use of ICBMs because they are fairly blind without accurate prelaunch reconnaissance information to precisely locate fixed enemy targets, to provide the latest data on movable enemy targets and to provide post-salvo information on damage results and to attack surviving targets. It is also necessary because there will always be significant military targets that are either too mobile for an ICBM assault or too well concealed. For these targets, an aerial vehicle will always be necessary to locate, attack and destroy.

Skepticism Justified

It is true that the B-70 decision, which was bitterly opposed by the Air Force and imposed on it by a stringent White House-Budget Bureau edict, does leave the shell of a Mach 3 aircraft research program remaining. However, in view of the preliminary whittling during this year on what was once a major program, certain skepticism appears justified in assuming that the whittling will not stop with the Fiscal 1961 budget decision and that even the remaining program will have difficulty in surviving another round of "economy" budgets. Next year it will be even easier to justify the final slash because of what little remains after the current chopping and its shift from a weapon system to a research program.

The basic effect of the B-70 budget slash decision is to artificially create a tremendous technical gap in our strategic deterrent force by dooming Strategic Air Command to rely primarily on its subsonic Boeing B-47 and B-52 bomber fleet until a significant Minuteman and Polaris missile force is emplaced some five to seven years hence. And even then it will leave this missile force without sufficient reconnaissance or follow-up strike capability to be truly effective as a strategic deterrent.

It may be difficult for military men trained by an organization that is still using the Browning automatic rifle designed in 1890 and a standard service pistol used against the Moros by the then Capt. John Pershing before the dawn of the 20th century, to fully comprehend the speed, scope and significance of the impact of modern technology on military weapons development. With this type of background it is not surprising that they are not disturbed by this yawning technical gap they are creating and still caution against a "tremendous hysterical urge about the business of getting something new."

Financial Wringer

Some people have suggested that this gap will be adequately filled by the Mach 2 Convair B-58 bomber. The B-58 is a fine weapon and a significant step forward in improving the military capability of Strategic Air Command. Until recently it has been pushed to the limit of its manufacturer's technical ability. It is still the only such aircraft existent in the world today. But the B-58 has been put through much the same financial wringer that is now squeezing the vitality from the B-70 program. Consequently, unless the course of these decisions is also reversed, the B-58 will enter the SAC inventory in too small quantities, too late to ever realize its genuine military potential.

On the civil side, the curtailment of Mach 3 aircraft development will hand to the Soviet Union another opportunity to strike a tremendous blow at this country's technical prestige and our air commerce, which today is unquestionably the finest in the world. The development of a supersonic transport will be the key to the next generation of international air transport. All current evidence points to the Mach 3 range as the most promising area for this effort.

As anybody in the aviation business knows, the development of an aerodynamic research vehicle to fly at Mach 3 and the cancellation of development on all of the vital subsystems required to make it function as a useful civil or military vehicle will make little genuine progress toward any significant goal. In fact, when the B-70 prototype flies in 1962 without these vital subsystems its achievement will be as hollow as its empty airframe. This will, of course, give its critics even more grounds to abolish the program because it obviously has not produced a truly useful vehicle.

This is the process of stretchout and technical emasculation by which we are letting the lifeblood of our technical ability spill out onto the barren ground of false economy. This is how we are braking the dynamics of our technical pace.

The B-70 stretchout decision is supposed to save $85 million in Fiscal 1961. This may be true but the ultimate price of this economy may be our existence as a free and independent nation.

—Robert Hotz

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WHO'S WHERE

In the Front Office

Carter L. Burgess, a director of American Airlines, Inc. Mr. Burgess is president of American Machine and Foundry Co. American also elected **Dwight D. Taylor** a vice president; he will continue in charge of the company's Washington office.

C. R. Able, vice president-defense programs, Douglas Aircraft Co., Inc., Santa Monica, Calif.

Dr. Coleman duP. Donaldson, president and a director, Aeronautical Research Associates of Princeton, Inc., Princeton, N. J. Also: **Roger D. Sullivan,** associate consultant and a vice president and a director; **Edward Seckel,** a director. Mr. Seckel is associate professor in the Department of Aeronautical Engineering at Princeton University.

James O. Leet, vice president for Irish Air Lines in North America, succeeding **Michael J. Dargan** who is returning to Dublin to resume the position of assistant general manager.

W. R. Clay, a division vice president and engineering department manager, Radioplane, a division of Northrop Corp.

Walter J. Kruel, executive vice president, Hallamore Electronics Division of The Siegler Corp., Anaheim, Calif.

Richard A. Campbell, vice president-operations, Pacific Semiconductors, Inc., Culver City, Calif., a subsidiary of Thompson Ramo Wooldridge, Inc.

Stanley L. Seltzer, assistant director, Air Navigation-Traffic Control, Air Transport Assn., Washington, D. C.

Rear Adm. Leonidas D. Coates, Jr., presently Deputy and Assistant Chief, Bureau of Aeronautics, assigned to the Office of the Chief of Naval Operations.

Clifford P. Burton, Chief of the Analysis Division, Office of Plans and Requirements, Federal Aviation Agency, Washington.

Honors and Elections

Dr. Howard S. Seifert, special assistant for professional development at Space Technology Laboratories, has been elected president of the American Rocket Society. **Dr. Harold W. Ritchey,** vice president and technical director of the Rocket Division of Thiokol Chemical Corp., has succeeded Dr. Seifert as vice president of the Society.

James S. McDonnell, Jr., president of McDonnell Aircraft Corp., has been elected chairman of the board of governors of the Aerospace Industries Assn., succeeding **C. J. McCarthy,** chairman of Chance Vought Aircraft, Inc. **J. V. Naish,** president of Convair Division of General Dynamics Corp., was elected vice chairman.

Jacqueline Cochran has been elected president of the National Aeronautics Assn., succeeding **Thomas G. Lanphier, Jr.,** a vice president of Convair, who was elected chairman. **Martin Decker,** president of Decker Corp., was elected first vice president.

Elmer P. Wheaton, vice president-engineering, missiles and space systems for Douglas Aircraft Co., has been elected chairman of the newly organized Guided Missile Council, Aerospace Industries Assn.

(*Continued on page 172*)

INDUSTRY OBSERVER

► Projections for test stands to accommodate 24 million-lb.-thrust powerplants are being analyzed for location at Edwards AFB, Calif. Big problem would be ability to control acoustic phenomena. Embodying a new design concept, test stands would serve Air Research and Development Command and National Aeronautics and Space Administration projects.

► **Bechtel Corp. is performing a study for Air Force Ballistic Missile Division under the Minuteman solid-propellant ballistic missile program to determine hard-base auxiliary power requirements to ensure missile operational capability if all other power sources to a base should fail.**

► Third Ballistic Missile Early Warning System (BMEWS) installation will be made at Fylingdale Moor in East Yorkshire, England, instead of in Scotland as earlier planned. New BMEWS installation is expected to have four large surveillance radar antennas, similar to system installed near Thule, Greenland, aimed so as to detect missiles launched from southern portions of Soviet Union or its satellites as well as missiles fired over polar region from northern sites.

► **Planning is under way to establish a specific timetable for transfer of responsibility for executive management of the Atlas ICBM from the Ballistic Missile Division to the Strategic Air Command for operational status and the Ballistic Missile Center for logistic support. Specific projections for transfer of Titan are scheduled to follow within the near future. These will be followed shortly by a timetable to switch the management responsibility for Minuteman, still in its early research and development stage.**

► Japan may order a total of 20-30 F-104Ds from Lockheed Aircraft Corp. if the Lockheed fighter is officially chosen for the Japan Air Self Defense Force. Aircraft would be used for training before the F-104C-J began coming off the production lines in Japan. Japanese probably would produce about 200 of the Lockheed fighters under license, and approximately 180 would be the two-seat F-104C-J version. F-104C-J has the same general weight, dimensions and performance as the basic F-104C, although some different avionic equipment will be used.

► **Samos, advanced television reconnaissance satellite of the WS-117L program, is being analyzed for logistics and support literature requirements relating to the time the system is expected to be phased into operational status with the Strategic Air Command.**

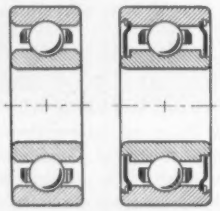
► In Sofar bomb development program related to the Atlas, Titan, Thor and Minuteman nose cone recovery techniques, Bermite Powder Co.'s Ordnance Research & Development Co. division is working on cutting down bomb weight by reduction of fuze weight and the substitution of aluminum for steel parts. Another refinement is development of a time fuze as a substitute for the hydrostatic type. Company also is working on stage separation devices for Minuteman and Mercury projects and destruct systems for Minuteman.

► **Martin is procuring research and development ground equipment costing almost $150 million for use in connection with captive trials and launchings of the Titan ICBM.**

► Automated repair-parts provisioning unit which could be applied to weapon systems such as the Polaris fleet ballistic missile and the succeeding generation ballistic missiles has been developed by Planning Research Corp. for the Naval Ordnance Supply Office.

► **Lockheed Aircraft Corp., Burbank, is analyzing future ballistic missile mobility possibilities encompassing transportation by rail, truck and water. Latter study includes large LST-type barges with provisions to be sunk and anchored in shallow-water bottom for the erection of the missile to vertical, then refloat barge after firing. Studies are company-funded.**

BARDEN "T" retainer combines aluminum and phenolic for greater strength, superior performance



"T" retainer bearings are available in chrome or stainless steel, open or shielded, from .5000" O.D. to 3.3465" O.D. in standard widths. Also available: extra-wide shielded sizes with increased lubricant space for still longer life. For complete technical information write for Engineering Data Sheet T-1.

Doubles bearing life in high speed applications

Power tools, gyro rotors, aircraft and missile accessories and other high speed applications require bearings that combine high load capacity and endurance at speed. To meet these exacting demands, Barden developed the "T" ball retainer which combines the advantages of phenolic with the strength of aluminum.

The two-piece "T" retainer has laminated phenolic center sections bonded to high-strength aluminum alloy side plates. It is securely joined by body-bound rivets tightly headed against metal at both ends. The retainer's thin cross section permits maximum exposure of balls and raceways to lubricant. Outer ring piloting provides optimum lubricant circulation.

These features, together with high load capacity, result in longer, trouble-free bearing life. For example, double shielded, grease lubricated "T" retainer bearings have operated continuously in textile spindles for more than 18,000 hours at 30,000 RPM.

Like other Barden advances in engineering and manufacturing, "T" retainer bearings solve a specific performance problem. Other Barden Precision ball bearings satisfy such extreme demands as:

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The complete Barden line includes sizes from .0469" bore to over 3" O.D., all manufactured to Barden Precision standards of dimensional accuracy, uniformity and reliability. Refer to Sweet's Product Design File (8h/Ba) for Barden catalog and bearing selection guide.

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Washington Roundup

New ASW Command

Watch for a Navy announcement within the near future of plans to establish an integrated anti-submarine warfare force in the Pacific along the lines of the Atlantic Fleet's Anti-Submarine Defense Force which has been in existence for the past few years. Commander of the new Pacific force being organized in an effort to tighten defenses against Soviet missile submarines will be Rear Adm. John S. Thach, who has commanded Task Force ALFA since it was organized early last year to carry out extensive maneuvers to help determine Navy's equipment needs in this field and to improve ASW operational techniques. Thach, who will gain the rank of vice admiral with the transfer, is expected to move into his new post early next year.

In a related move, the Navy announced last week that Rear Adm. Edmund B. Taylor, now commander of the Atlantic Fleet destroyer force, will succeed Vice Adm. William G. Cooper as commander of the Atlantic Fleet's Anti-Submarine Defense Force. Taylor also will be promoted to the rank of vice admiral.

Navy also named Vice Adm. William R. Smedberg III to the post of deputy chief of naval operations for personnel, replacing Vice Adm. Harold P. Smith. No new assignments were mentioned for either Cooper or Smith, but Smith has been mentioned prominently in the past as a possible successor to Adm. Jerauld Wright as commander of the Atlantic Fleet and NATO sea forces upon the latter's retirement next year.

Patent Policy Review

Controversial National Aeronautics and Space Administration patent policy may eventually inspire a complete overhaul of national patent policy. Unlike other federal agencies, NASA is legally required to take title to all inventions made under its contracts and this situation has prompted the National Council of Patent Law Assns. to launch a thorough review of all existing and proposed U. S. patent regulations. Review will be made to help Congress frame legislation to establish a uniform national patent policy for all federal agencies.

Apples and Oranges

Richard E. Horner, associate administrator of the National Aeronautics and Space Administration, was asked on a television news program last week why the U. S. did not follow the Russian plan of using "rockets in depth" and more than one of the same type of vehicle to back up specific space efforts. Horner replied:

"I think we have generally formed our program around a concept of a broader scope of different kinds of endeavor than the Russians have and relied on a backup in the sense of a flexibility in switching from one endeavor to another, rather than to use our resources all in one specific endeavor . . ."

Asked a moment later, "What are some of the different areas where we are preparing projects in which the Russians are not also?", Horner said:

"I find it pretty difficult to answer that question in the context of what we are doing that the Russians are not doing because we have very little information on what the Russians are doing until after they have done it. And of course we are talking now mostly about things that we are proposing to do . . ."

Accident Data Release

Protests by the Civil Aeronautics Board against the Federal Aviation Agency practice of releasing recordings of tower-pilot conversations immediately after an accident are not likely to bring about any changes in the policy. FAA officials point out that any broadcasted information automatically becomes public information since, once it is on the air, it is available to any listener. For this reason, FAA says the information cannot be successfully withheld, and, therefore, will be released —a practice that is never applied to other data surrounding an aircraft accident. According to FAA, the CAB has been the sole objector to the policy, and no similar complaints have been received from air carriers.

Bahamas Guest List

Controversy over releasing names of officials entertained by the Martin Co. at the luxurious Eleuthera Club in the Bahamas (AW Sept. 21, p. 25) came to a close last week when the House Armed Services Investigating Subcommittee released a guest list of over 25 high-ranking officers, Defense Department officials and industry representatives.

George M. Bunker, Martin board chairman, presented a list drawn from his recollections to the subcommittee in executive session in September. Bunker called on the subcommittee, headed by Rep. Edward Hebert (D.-La.), to make the list public. Hebert replied that the list was Bunker's, and it was up to him to make it public.

Subcommittee released the list last week after an individual check on each of the names supplied by Bunker. The guests included Air Force Secretary James H. Douglas and Gen. Nathan F. Twining, chairman of the Joint Chiefs of Staff. It was specified that Douglas paid his own expenses. Twining was a Martin guest in the Bahamas on three occasions: Mar. 7-10, 1957; Feb. 14-16, 1958; Feb. 26-Mar. 1, 1959.

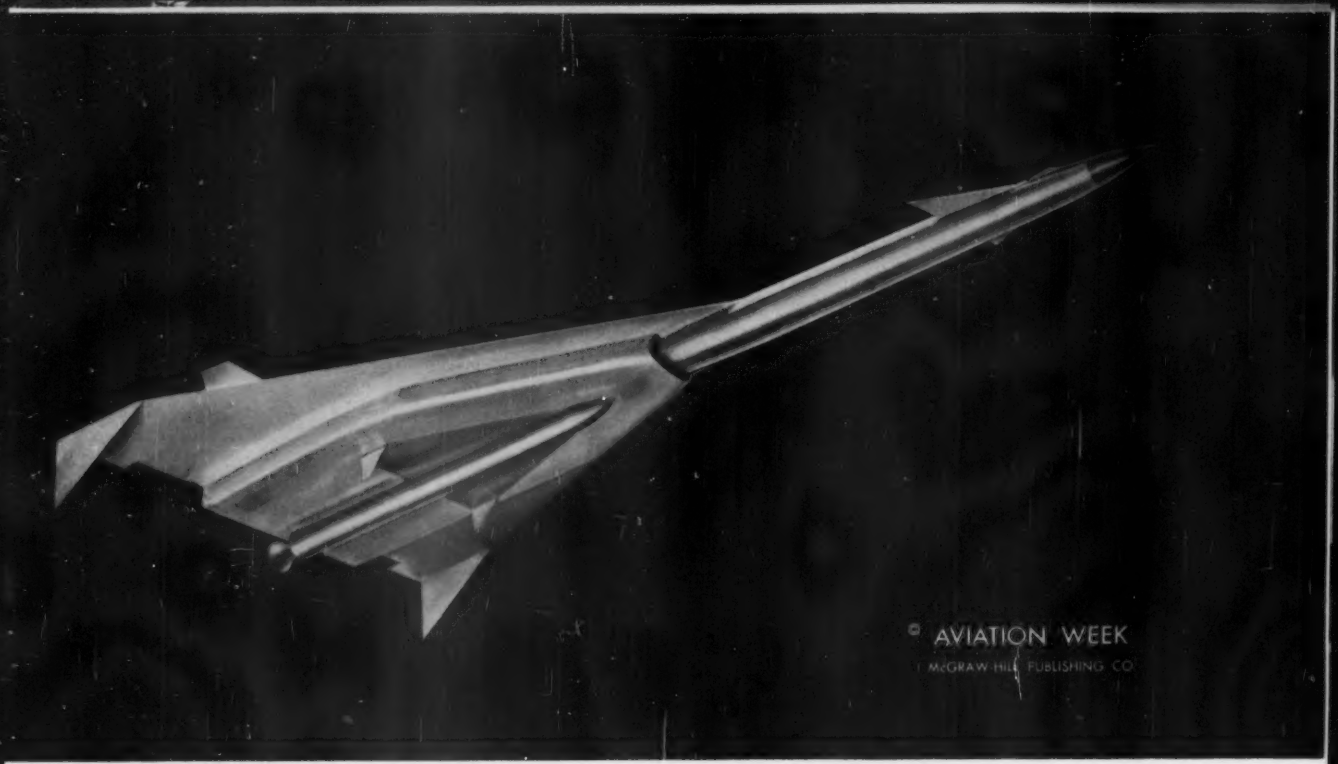
Chavez Budget Views

Sen. Dennis Chavez (D.-N. M.), chairman of the Senate Appropriations Subcommittee for the Armed Services, is satisfied with an over-all figure of $41 billion for the Fiscal 1960 defense budget. The area in which to make savings, Chavez suggests, is in tightening up on contracts. "Purchasing needs closer supervision," he commented last week. The greatest need for improvement in the military establishment, he added, is in housing and hospital facilities.

Christmas Mail Boost

Christmas mail deliveries will be expedited this year as a result of an agreement between the Post Office Department and 17 airlines. Pending a Civil Aeronautics Board decision on the air transport of non-priority mail (AW Nov. 23, p. 46), the carriers have agreed to transport first-class mail on a space available basis this month at rates of approximately 50% of those currently paid by the Post Office for the carriage of service mail. The one-month trial, however, is intended only to aid airmail delivery during the holiday season and has no bearing on the final outcome of the non-priority mail case.

—Washington staff



AVIATION WEEK artist's conception of B-70 carrying a Dyna-Soar type vehicle is one of several missions proposed for the aircraft.

Budget Cuts Force Stretchout of B-70

Major subsystems eliminated, flight date delayed; North American will recall airframe subcontracts.

By J. S. Butz, Jr.

Washington—Stretchout of the North American B-70 Mach 3 heavy bomber program, including the elimination of major subsystems, was announced by the Air Force last week after its appropriations request for the project was reduced by the Administration from $160 million to $75 million for Fiscal 1961.

The reduction in funds will cause the layoff of approximately 2,000 North American employes in its Los Angeles Division and has forced the cancellation of contracts for three major B-70 subsystems under development. These are:

- **Inertial type** bombing-navigation system being built by the Federal Systems Division of International Business Machines Corp. The stable platform, which is the heart of the system, was subcontracted to the Autonetics Division of North American. Approximately $58 million had been spent on this system thus far.
- **Electronic countermeasures** system for passive defense of the aircraft against guided missiles which was under design by the Air Arm Division of Westinghouse Electric Corp. Investment in this system amounts to about $2.5 million to date.
- **Mission and traffic control** package consisting of communications, navigation and avionic identification equipment. Western Military Electronics Center of Motorola, Inc., was the subcontractor and approximately $300,000 had been spent on the system.

A total of approximately $550 million has been appropriated for the B-70 program through Fiscal 1960, and all but $25 million of this has been released by the Department of Defense. Exact commitment of funds to date has been estimated at between $150 million and $200 million, but the Air Force plans to use all of the $525 million that has been approved and released for the B-70 thus far. Appropriation for the project in Fiscal 1960 was approximately $150 million.

North American has received permission from the Air Force to bring all other major subcontracts back into its own Los Angeles Division in an effort to reduce expenditures. The contracts affected are with Boeing Airplane Co., which was building the B-70 wings; Georgia Division of Lockheed Aircraft Corp. for the upper fuselage, and Chance Vought Aircraft, Inc., for the vertical and horizontal stabilizers. Approximately $1.79 million have been spent with Boeing, $7.5 million with Lockheed and $4 million with Chance Vought.

It is estimated that a one-year stoppage of the long lead time bombing-navigation, electronic countermeasures and mission control avionics systems will extend the earliest possible operational date from 1965 to 1967.

Original Air Force plans were to bypass the prototype phase with the B-70 and cut several years from its lead time by building production aircraft from the beginning. Under this arrangement, 13 test aircraft would have been built, one for static load testing and the others for flight. Most of this group would have entered operational service after the flight test program was completed.

The present funding situation, however, will make it possible to build only one aircraft, probably to be designated the XB-70. Prototype flying will precede production aircraft by several years. This type of development schedule has been customary in the Air Force and was used for the B-47, the B-52 and most other large aircraft. First flight of the production type B-70s had been

planned for 1962 but, under the new plan, the single test aircraft will not fly until 1963.

If a significant number of completely equipped B-70s is to be in operation before 1970, a decision will have to be made next year by the Administration to reinstate the bombing-navigation, electronic countermeasures and mission control system projects. A number of industry and Air Force officials believe that the Administration's hold-the-line defense spending policy will not be changed for Fiscal 1962 and that there is little chance that any multi-billion dollar bomber production will be embarked upon while missile production remains high. They believe that the final argument between the manned aircraft and the long-range guided missile has been decided within Administration circles in favor of the missile.

USAF Reaction

Top-level Air Force officials, however, are believed to favor an all-out appeal to Congress and another bid to the Administration for reinstatement of the original B-70 program. The Air Force and its advisers such as Theodore von Karman (AW Sept. 21, p. 26) are reluctant to abandon the concept that a mixed force of missiles and manned aircraft is necessary in any future conflicts. One part of the effort to make the B-70 more attractive economically has been to make extensive studies of the aircraft's multi-mission capability.

Under these studies, it has been concluded that the aircraft could serve as a:

• **Recoverable first stage booster** for satellites and Dyna-Soar-type boost glider vehicles. The B-70 could drop a 10,000 lb. glider with about 40,000 lb. of upper-stage boosters at 70,000 ft. and at Mach 3 speed. This rocket could reach a 300-mi.-high circular orbit. Maximum payload of the B-70 for short ranges should approach 100,000 lb.

• **Transport with about** 80-passenger capacity. If the fuselage were widened and lengthened somewhat, the passenger load could be doubled. Such an aircraft probably would be out of the financial reach of U.S. airlines if it did not come as a bonus from the B-70 program. Soviet officials have stated publicly that they have a supersonic transport under development.

• **All-weather interceptor** for the Air Defense Command. This proposal has raised many doubts as to the economics of operating a 400,000 to 600,000 lb. aircraft for air defense, and it can undoubtedly be shown that it is cheaper to use several smaller fighters than one B-70. However, if the B-70 should be the only Mach 3 aircraft built in the U.S., it may prove advantageous to incorporate some of them into air defense. They could carry a large number of air-to-air missiles, very long range search and fire control radar and, once they were in the air, do the work of at least three Mach 2 fighters. The B-70 in its SAC configuration is designed to be off the ground in less than five minutes after receiving a warning, including simultaneous starting of its six engines plus a very rapid automatic checkout of its avionics systems. This would aid in its conversion to a fighter with fast reaction and scramble potential.

• **Armament of the B-70** could vary from bombs, air launched ballistic missiles, air-to-ground cruise missiles, to manned parasite bombers and reconnaissance aircraft which could return to the B-70 or directly to a SAC airfield. Operation of this wide variety of weapons either has been accomplished in the past by other aircraft or was planned before the B-70 was originally scheduled for first squadron service in 1964 or 65.

• **Great size** of the B-70 would allow it to be converted to nuclear power once the U.S. develops this type of aircraft powerplant. The crew compartment is about 75 ft. ahead of the common air intake for its engines which would ease the personnel shielding problem. The six jet engines are located next to each other so that they all could be supplied with heat from one central reactor which probably would be located aft of the duct inlet near the center of lift of the wing.

Most of the B-70's multi-mission attractiveness stems from the fact that its thrust-to-weight ratio is very high for a large aircraft. It will weigh something less than 600,000 lb. and have a total of at least 180,000 lb. of thrust in its six General Electric J93 engines. The Boeing B-52, by comparison, weighs around 400,000 lb. with 80,000 lb. of available thrust. Its power advantage should enable the B-70 to operate out of B-52 airfields with room to spare and contribute to good performance in all types of flight.

York's View

A statement last August by Dr. Herbert F. York, Defense Department director of research and engineering, appears to reflect generally the attitude of officials favoring missiles heavily.

After stating that "we simply are not prepared to answer . . ." whether the now-canceled F-108 or the B-70 programs would reach the hardware stage, he added that, "some people have lingering doubts" about the capability and accuracy of missiles, but "I don't have any doubts myself."

Maj. Gen. John B. Medaris, retiring commander of the Army Ordnance Missile Command, recently said he felt "the manned bomber is necessarily on the decline because of the growing

V-STOL Fighter

Air Force will buy a new jet fighter—possibly a V-STOL—for which contractors will be asked to submit design entries early in 1960. Competition ties in with current discussions between Tactical Air Command and USAF Air Staff concerning configuration of fighter needed. Funding already has been set aside for Fiscal Year 1960 and 1961 programs, and will be made available when the competition is completed. USAF anticipates it will spend the already approved money in 1960. Design entries are expected from Northrop, Convair, Bell, McDonnell and Republic.

Need for a manned fighter-bomber capable of operating from hover and slow flight up to Mach 2 was pointed out by Dr. Howard A. Wilcox, deputy director, research and engineering, Department of Defense, in a speech to the American Ordnance Assn. in New York last week.

Mercury Capsule Order

Washington—National Aeronautics and Space Administration has ordered another six Mercury capsules from McDonnell Aircraft Corp., bringing the total order to 20. Initial deliveries are expected to begin within a month, and NASA will use the first capsules in qualification testing, including a launch on the Little Joe booster. McDonnell is building the capsules on a seven-day-week production schedule.

Life on Venus?

Washington—Possibility that life may exist on Venus was raised last week after data from a Navy high-altitude balloon flight revealed the presence of water vapor in clouds surrounding the planet.

Cmdr. Malcolm Ross and meteorologist Charles B. Moore of Arthur D. Little, Inc., went to 81,000 ft. in a Navy balloon equipped with a telescope and a spectroscope designed by Dr. John Strong of Johns Hopkins University.

Preliminary inspection of the data recorded indicates that water vapor definitely exists around Venus, but more definite information will be needed about surface temperatures before definite conclusions can be drawn as to the existence of even the most elementary forms of life on the planet.

Scientific opinion is widely divided at present over the range of temperatures on the surface of Venus, with many of the observations made by radio telescopes running above 200C. Other observations have indicated temperatures similar to those on earth.

Lockheed YP3V-1 ASW Electra Version Makes First Flight

Operational prototype of U. S. Navy's Lockheed YP3V-1 antisubmarine patrol plane (AW Feb. 23, p. 30) has made its first flight at Burbank, Calif. Tail boom on Electra version houses electronic detection gear and new nose section carries radar equipment. Powerplants are Allison T56-10-W turboprops developing a total of 18,000 shp. at takeoff. Plane can be fitted to carry external rockets. Company says the YP3V-1 can search 280,000 sq. mi. in a single flight at a cost of about one cent per square mile. Cruise speed is about 400 mph. Airline type windows have been replaced with large observer stations.

strength of the air defense in terms of guided missiles, both our own and our opposition's. What the time period will be I don't know, but certainly it is definitely declining, and I should think that four or five years would see it in a secondary role."

Fundamental Air Force doctrine as it now stands depends heavily upon the B-70 and, if the aircraft fails to reach operational service, this doctrine probably will require a basic overhaul. Air Force leaders believe that air supremacy by manned aircraft is still required and that it will continue to be required for the next 10 years at least—the maximum period for which firm operational equipment needs generally are projected.

Air supremacy, USAF believes, depends upon ability to penetrate all targets, no matter how well they are defended. Penetration of manned aircraft over enemy territory is the only way the Air Force feels it can receive adequate information on damage the enemy has received and on his actions during the second phase of any all-out nuclear war. Manned aircraft also are considered by USAF to be the only weapon that can ensure the success of attacks against relatively small targets such as airfields.

Air Force estimates of missile capabilities are that no long-range missile will have the accuracy or yield of weapons dropped from bombers before 1970. Absolute destruction of targets smaller than large cities will require large numbers of missiles before that period, although the ultimate accuracy of ICBMs is predicted to be good enough to destroy missiles in hardened sites on a one-for-one basis at 5,000-mi. range. Reconnaissance satellites and missiles with automatic equipment will not be accurate or reliable enough to be considered for this vital mission before 1970, according to some Air Force officials.

Soviet Defenses

The doctrine of manned penetration is now being implemented by a subsonic bomber fleet. However, the Russian air defenses against this force are being steadily increased, according to intelligence estimates. Air Force planners believe that this defense already is strong enough to lower the penetration rate of subsonic bombers with current equipment to an unacceptable figure. Steps have been taken to increase the effectiveness of the present inventory of bombers through development of such items as the Hound Dog air-to-surface missile, the Green Quail decoy missile and more sophisticated electronic countermeasures apparatus. An extensive reequipment of SAC with these items is scheduled to begin this year. The maximum production of the Hound Dog is scheduled for 1960.

Contrary to some reports, the primary purpose of the Hound Dog is not to enable a B-52 to attack a target from distances beyond enemy defenses. The normal mission is for each B-52 to reach its prime objective after releasing its two Hound Dogs at other targets on the way in. Number one objective for Hound Dogs on the first wave of bombers are the ground-launched missile installations of the enemy air defense system. It is expected that the bomber forces will attack in numbers and fight their way to the main objectives. According to Gen. Earle Partridge, retired commander of the North American Air Defense Command, the easiest air defense situation is an attack by single aircraft or small groups, with maximum penetration being obtained by attacking with closely spaced waves of large groups of aircraft in one air defense sector.

U. S. plans apparently are to attack in such formations screened by ECM and decoy missiles, while firing large numbers of Hound Dogs at the ground-based defense missiles, radar installations and airfields.

If Soviet air defenses continue to be improved at the present rate, Air Force believes any subsonic attack will become marginal after 1965, even with the most advanced equipment. Stand-off missiles such as the air-launched ballistic missile or cruise type missiles are not considered to be any more desirable than missiles launched from land or sea if they are not used to assist an aircraft in penetrating over a target. Manned aircraft, USAF planners say, cannot be justified simply as long-range missile launchers.

Dyna-Soar-type weapon systems with extremely high speeds are considered by the Air Force to be at least 10 years away from operational status and that only weapons that have been under serious development during the last three-to-four years should be counted upon to aid the U. S. defensive posture before 1970.

French Delay Mirage Bomber Decision

Paris—French military budget for 1960 contains authorization for the eventual ordering of 50 Dassault Mirage 4A strategic bombers although final decision on production of the twin-engine bomber is being held up.

Pierre Guillaumat, French armed forces secretary, revealed this at the end of the National Assembly debate on the 1960 military budget. Mirage 4A, of which a single prototype is flying, is powered by two Snecma Atar 9 afterburning turbojets. It is capable, Guillaumat told Assembly deputies, of carrying the French atomic bomb which "we hope to manufacture."

Production of this first French strategic bomber, however, still remains under a cloud. Guillaumat said "the decision to build the production version depends on a new decision of the prime minister and probably of the entire national defense committee."

Earlier in the Mirage 4A debate, Guillaumat defended his department's decision, made several months ago, to stay with the Atar-powered Mirage 4 instead of using Pratt & Whitney J75 turbojets (AW Nov. 30, p. 99). Range of action of the Atar version, he said, permits it—with or without in-flight refueling—to fulfill missions as defined by French policy.

Although Guillaumat didn't elaborate on this point, it is generally understood that Atar-powered versions of the Mirage would fly one-way strategic missions, landing perhaps in the Near East after overflying Russian targets. Many French military theorists argue that in an atomic war, it isn't worth worrying about returning planes to takeoff point.

In addition to the 50 Mirage 4A bombers, the 1960 budget includes authorizations for 100 additional Mirage 3 interceptors. This brings to 200 the total number of Mirage 3s authorized by the French Defense Ministry. Other items in the air force budget include authorizations for the ordering of 130 Fouga Magister trainers and some $13 million earmarked for purchase of 100 surplus Douglas AD-4 Skyraiders and 30 Douglas DC-3s. The Skyraiders, plus 220 North American T-28 Nomads, will be used in Algeria.

In all, the 1960 air force budget totals some $745 million, of which $380 million is to be used for research and development projects, new orders and construction. Air force section represents 22% of the over-all military budget. Five years ago this percentage was 28%. Over the past five years, air force personnel has dropped some 26%.

Within the over-all military budget there is an item for $84 million which represents new authorization for nuclear weapon development. Another item earmarks some $20 million of authorization funds for development work on an intermediate range ballistic missile project, "either French or Allied."

Use of American surplus trainer aircraft as ground support fighters in Algeria came in for heavy criticism during the budget debate.

Since 1956, the French air force has armed hundreds of surplus North American T-6s with rockets and machine guns for use in ground support operations against Algerian rebels, but now is pushing through a replacement program, using the T-28s.

Deputy Armand Cachat criticized the government for trying to make trainer-type aircraft—like the T-6 and the T-28A—do the job of combat aircraft. In 1958, 40 pilots were killed and 20 injured, he said. Up to Aug. 15 of this year, he reported T-6 pilot losses as being 25 killed and 11 injured.

In answer, Guillaumat explained that 50% of such losses were due to effective rebel anti-aircraft fire, and not to the qualities of the T-6.

Squabble over use of American surplus aircraft in Algeria spotlights this aspect of the French aircraft industry: over the past five years it has designed and developed prototypes of at least five aircraft specifically designed for the type of warfare the French have been fighting in Indochina and in Algeria. These aircraft began with the Potez 75 and include such prototypes as the Morane-Saulnier Epervier, the SIPA 1100, Sud Aviation's Voltigeur and Dassault's Spirale. Each of these aircraft was designed at the request of French Defense Ministry. But the Ministry has continually abandoned these French projects to buy American surplus aircraft at cheaper cost.

U. S. Refuses French IRBM Aid

Paris—French development of an intermediate range ballistic missile is being held up by the refusal of the United States to work with France on a bilateral basis (AW Nov. 2, p. 37).

Informed sources told Aviation Week that American aircraft companies last August were ordered by the U. S. government to cease all cooperation with the French on IRBM studies. The order, these sources claim, has just about brought to halt any French IRBM activity. French officials have admitted it would be impossible for France to develop the IRBM and that U. S. aid would be necessary.

Reason for U. S. unwillingness to cooperate bilaterally with France on an IRBM project is not completely clear. It's likely the U. S. prefers to work out an arrangement under which U. S. technical aid would be given to a group of NATO nations for development of a NATO-controlled IRBM, rather than help France develop an independent weapon which would be controlled only by France.

It was understood that the U. S. decision was jointly agreed to by both Pentagon and State Department officials.

At the time the U. S. reached its decision, several U. S. aircraft companies in Europe already were deeply involved in talks with the French missile study group. This outfit, known as (SEREB) Societe d'Etudes et de Realisations d'Engins Balistiques (AW Aug. 10, p. 28) was set up earlier this year. It is composed of most French aircraft companies plus several government agencies. SEREB's mission is to coordinate efforts of French companies in building of an IRBM as well as to deal with American companies which were slated to take part.

Idea was that the French IRBM missile, probably in the 1,500-2,500 mi. range and fueled by solid propellants, would be built with American technical aid and be armed with French nuclear warhead. It was to be ready by 1965.

U. S. aircraft companies, anxious to participate in French IRBM program, by the end of last August already were working out various projects with the French when, as one source in Paris put it, "all hell broke loose." Since then, no further talks or information have been exchanged between the American companies or government officials and the French. As yet, no official recognition—either from French or U. S. sources—has been made of the new situation. Apparently President Eisenhower's visit with Gen. Charles de Gaulle in Paris last September did not alter the U. S. decision.

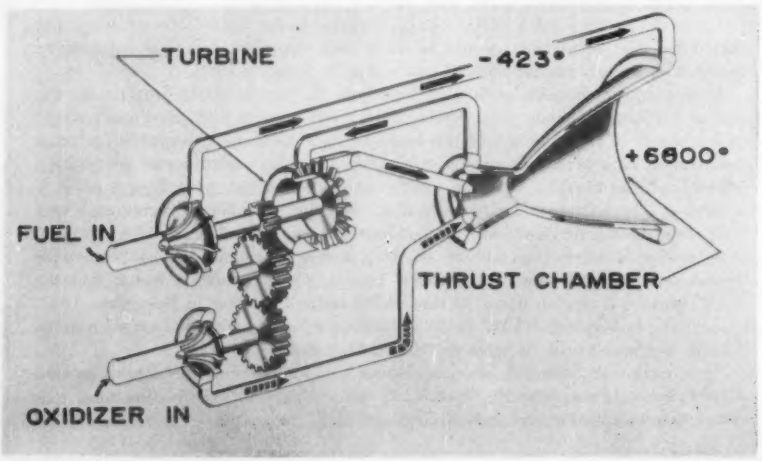
It was impossible to learn whether the U. S. ever really intended to cooperate with France on a bilateral basis on the IRBM project. One speculation had it that the U. S., under a resolution passed at the NATO summit meeting in December, 1957, was willing to help the NATO group develop an advanced type weapon such as an IRBM, but wasn't ready to work out the bilateral deal.

U. S. companies, however, knowing France was interested in developing its own IRBM, began talking with the French. It was at this point, speculation runs, that Washington stepped in and slapped down the U. S. companies.

Space Technology

Centaur Tests New Hydrogen Pump Cycle

FIRST PHOTO of complete Pratt & Whitney XLR 115 liquid hydrogen rocket engine being developed for Convair Centaur upper stage for space vehicles shows propellant pumps and turbine, which eliminates separate gas generator used in most liquid engines. Diagram below shows flow cycle of liquid hydrogen fuel and liquid oxygen oxidizer in XLR 115.



Washington—Pumping cycle that eliminates the need for a gas generator is being used on a rocket engine for the first time in firings of the hydrogen-fueled Pratt & Whitney XLR 115-P-1.

This 15,000-lb.-thrust engine is being developed for the National Aeronautics and Space Administration. Two engines will power the Convair Centaur upper stage for space vehicles. Specific impulses produced are 30% higher than with kerosene-fueled rockets.

Several XLR 115s have been fired for as long as several minutes in a number of runs at Pratt & Whitney's Florida Research and Development Center near West Palm Beach, Fla. (AW July 27, p. 28). Hydrogen pumps of flight design have been run there for more than two years.

The XLR 115 turbopump cycle (see diagram) eliminates the gas generator used on most liquid rocket engines to provide turbine power for pumping propellants by capitalizing on the great energy released as extremely cold liquid hydrogen is expanded into a gas.

Hydrogen is stored in the fuel tank at minus 423F and under slight static pressure. First step in the cycle is to open a fuel line valve, allowing the hydrogen to pass through the pump. Combination of the pressure and the much higher relative temperature of the engine parts causes rapid expansion of the hydrogen through a conventional regenerative cooling system surrounding the nozzle and combustion chamber. Even though the engine has not yet fired and the nozzle and chamber are at the relatively cold temperatures of space, they are several hundred degrees warmer than the initial temperature of the hydrogen.

The hydrogen, now in gaseous form, passes through the turbine. The turbine is geared to run both the fuel and the liquid hydrogen pumps. From the turbine, the gaseous hydrogen flows into the combustion chamber. Because of the precision required in the complex missions the Centaur stage will have to perform, the cycle from tank to thrust must be completed in less than a second.

Once combustion has begun, temperature inside the chamber reaches approximately 5,500F. The great expansion caused by the heat exchange as the hydrogen passes through the cooling jacket continues the operation of the turbopump cycle.

The XLR 115 cycle also allows fuel tank pressures to be lower than in conventional systems, permitting the use of lighter tanks.

Charles T. Roelke, general manager of the center, says this work has shown that there is no technical obstacle that

would limit the size of hydrogen engines of similar design.

At least three companies—Pratt & Whitney, Aerojet and Rocketdyne—have experimented with liquid hydrogen engines of thrusts above 100,000 lb., but no government agency has yet contracted for the development of the larger engines.

NASA reportedly has been limited by a lack of funds from initiating development of larger hydrogen rockets, although this may be done next spring. Air Force is understood to have withheld initiation of larger engines, both because of lack of specific requirements and an uncertainty as to whether such an engine belongs in the national booster program, which is under the supervision of NASA.

Space Technology

Third Atlas-Able Lunar Launch May Be Attempted Despite Failures

By Evert Clark

Washington—Possibility remained last week that the U. S. will try again to send a 372-lb. payload into orbit around the moon using an Atlas-Able vehicle, although two Atlas-Ables have been lost at a combined cost of some $12 million and Atlas is in demand both for military use and for a number of other space programs.

First Atlas-Able vehicle exploded at Cape Canaveral, Fla., in September (AW Sept. 28, p. 30) following a static test of the Atlas engines. A launch attempt using a second vehicle failed Nov. 26, apparently because a 10-ft. glass fiber fairing around the payload gave way prematurely.

No backup vehicle existed as of late last week, but a backup payload is ready for firing if and when a vehicle becomes available. The lost payload and its backup cost an estimated $2 million to design and fabricate.

Whether another attempt will be made soon depends to a great extent on what government circles call "the prestige factor"—the degree of urgency attached to the mission in view of Soviet successes in space.

Soviet Launches

Explosion of the first Atlas-Able occurred while Soviet Premier Nikita Khrushchev was visiting the U. S. It was bracketed by successful Soviet launching of a lunar impact vehicle and a vehicle which photographed the moon's far side and went into an earth-moon orbit (AW Nov. 2, p. 26).

National Aeronautics and Space Administration, working under a tight budget, had not programed a backup vehicle for the first Atlas-Able when the program was initiated in November, 1958. Then, Atlas 20-D, scheduled for the Mercury program but not needed because an earlier shot produced sufficient information, was shifted to the lunar mission.

The payload was the largest and most scientifically ambitious that the U. S. has attempted to launch so far. That fact, plus the pressure of Soviet achievements, meant that a great many hopes were riding on the Thanksgiving Day firing.

Atlas-Able launch was witnessed from the central control building at Air Force Missile Test Center's Cape Canaveral launching site by a group of officials including NASA Administrator T. Keith Glennan, Defense Director of Research and Engineering Herbert F. York, USAF Assistant Secretary for Research and Development Joseph Charyk, and Dr. Louis Dunn, president of Space Technology Laboratories, Inc., whose company handled systems engineering and technical direction of the vehicle and payload.

Weighing against the probability of using another Atlas-Able for the lunar mission are costs and priority. NASA estimates the expense of the program so far at $12 to $15 million.

If it is decided that cost of another vehicle could be absorbed, availability could present a problem. Atlas is now scheduled to boost NASA's Mercury manned capsule and USAF's Midas and Samos military satellites into space, in addition to serving as the only currently operational U. S. intercontinental missile.

Atlas will form the first stage of the Vega and Centaur space vehicles. Neither of these is likely to be used to launch the existing 372-lb. payload because they have far greater payload capability, and neither will be ready in less than a year. Only a vehicle of Atlas-Able size or larger can boost the payload to the moon, so if it is not to be scrapped, another Atlas-Able apparently is the only answer.

If the decision is made to go ahead, obtaining another Atlas should be relatively easy, since Convair's Astronautics Division is producing the missiles only at about half capacity. Time required to obtain the booster might mean a substantial delay, however.

NASA Associate Administrator Richard E. Horner said last week that no backup vehicle existed for the lunar mission, but he said "we have under study currently the possibility of changing our schedule to get the most out of the resources that we have available."

The Nov. 26 failure was tentatively blamed upon failure of the aerodynamic shroud around the payload. Atlas was launched successfully, but 45 sec. later the shroud apparently fell off, exposing the payload to severe pressures. Two-piece shroud was supposed to have been separated by explosive bolts at 175 sec. after launch, after the vehicle had reached some 13,500 fps. velocity.

Parts of the payload found near the launching site indicated it may have been torn from the 98-ft. Atlas-Able vehicle, but the possibility remained that the 20-lb. thrust hydrazine and aluminum oxide engine in the payload may have exploded.

Telemetry Lost

Some telemetry was lost at 40 sec., more at 70 sec., and by 104 sec. after launch, all telemetry on upper stages had been lost. Tracking information and first stage telemetry indicated that the last Atlas engine cut off within one second of its 385 sec. scheduled burning time. There also were indications that the Aerojet AJ10-101A-powered second stage fired, but there was no indication of whether it separated from the Atlas. Part or all of the first and second stages fell into the Atlantic Ocean off the African Coast. Third stage, powered by the Allegany Ballistics Laboratory X-248 solid propellant engine, may have torn off or exploded shortly after launching.

Payload contained 121.2 lb. of scientific instrumentation, transmitting equipment and power supply aimed at measuring micrometeorite impact, hard radiation, total radiation flux, low-energy radiation, very low frequency radio waves and magnetic field. It also was going to scan portions of the lunar surface and transmit a crude television-like picture.

The 194.8-lb. payload engine, making its first flight, was to have supplied the final increment of velocity, make as many as three velocity corrections during the 2.6-day flight and slow the payload as it neared the moon in an attempt to put it into elliptical orbit with its nearest point at 3,000 mi. and its farthest point at 4,000 mi. from the lunar surface. This would have given the orbiting payload a 12-hr. period.

Satellite was a paddlewheel type (AW Sept. 7, p. 29) similar to Explorer VI. Power was to be derived from 8,800 solar cells on four paddle-like arms that were to have folded outward by spring action before the payload separated from the third stage.

ARPA Backs Solid Propellant Research

Washington – Advanced Research Projects Agency plans to increase the funding and scope of solid propellant research as this ARPA program goes into its second year.

Contracts, the first of which were awarded a year ago (AW, Nov. 3, 1958, p. 34), are aimed at the development of high-energy solid rocket propellants which reportedly would have specific impulses of approximately 320 sec. In all, ARPA let 54 contracts on an annual renewable basis.

Four of these contracts—the largest—were for integrated research on complete solid propellants. The other 50 were for supporting research in these five fields: propellant performance, specialized synthesis, ingredients research, high temperature research and basic research.

Funding for the four integrated research contracts last year totaled $6 million; this year it will be boosted to approximately $6½ million. Contractors are Esso Research and Engineering Co., Dow Chemical Co., Minnesota Mining and Manufacturing Co. and American Cyanamid. ARPA has authorized extensions of all four contracts. Actual contract negotiations are carried out for ARPA by the three military services.

Funding for the second year of the Dow contract, which is the only one of the four actually in the negotiating stage, has been authorized at $2,298,000. Esso, which was awarded a $1,264,000 contract by ARPA last year, will receive $1,722,000 for its work for the forthcoming year.

Minnesota Mining, whose contract is up for renewal Feb. 1, will get $1,515,000, and American Cyanamid will receive $1 million.

ARPA's 50 supporting solid-propellant research contracts will be renewed as they come up over the next few months at approximately their first-year funding levels. Among the extension authorizations already approved are Atlantic Research Corp., $200,000 for specialized synthesis work—one of 18 in this field; New York University, $265,000, also for specialized synthesis; Allegany Ballistics Laboratory (Hercules Powder Co.), $355,000 for propellant performance research—one of 11 contracts in this area. Soon up for renewal and expected to be approved is ARPA's contract with Allied Chemical Corp., which last May received $750,000 for research on high energy oxidizers.

In addition, ARPA recently signed a new supporting solid-propellant research contract with Jet Propulsion Laboratory. Contract is for research in non-destructive testing and is funded "at the $1 million level." ARPA currently is in the process of negotiating another new contract on the "deflagration to detonation phenomena." Funding for all contracts is available in ARPA's Fiscal 1960 budget, which went into effect last July.

The ARPA solid propellant research contracts are aimed generally at the development of "more energetic solids to vastly increase our present capability." Contractors are given end objectives, rather than detailed specifications.

As the director of one company's program on an integrated ARPA contract put it: "These contracts, at least the four integrated ones, are among the more intelligent contracts negotiated by the government; they don't tie your hands or really limit you in any way."

In this program, ARPA is looking for breakthroughs rather than simple advancements in solid propellant technology. Most of the contracts involve fairly basic research. Primarily for this reason ARPA chose its industrial contractors mainly from old line chemical and petrochemical companies which had established research groups with extensive backgrounds in relatively basic areas of chemistry, physics and combustion rather than from the solid propellant processors.

ARPA's solid propellant contractors maintain close liaison and are kept up to date on each other's progress. The four companies holding the integrated contracts, for example, meet formally each quarter. ARPA and the three services are represented at these meetings. In addition, contractors get together frequently on an informal basis.

Having started at essentially the same base line, the four holders of the integrated ARPA research contracts today stand at roughly the same progress mark.

No ARPA contractor has come up with a new compound. This is expected to take another year or two and there is some disagreement as to what the end product will be when it is developed. Some contractors believe it is more likely to turn out to be a high-energy storable liquid propellant than the high-energy solid originally sought (AW Nov. 30, p. 23). A high-energy monopropellant, according to others, also is a possibility.

Whatever it proves to be, the new propellant is expected to make use of fluorine as the oxidizing element. While it is possible to increase the energy level of all solid propellant constituents, most of the current research is being concentrated on the oxidizer. Because the oxidizer accounts for the largest percentage of the total propellant, ARPA contractors feel that improvements in this area will provide the best over-all return on any research investment.

Nor is it any coincidence that most of the ARPA contractors in this area are currently trying to get fluorine to do the oxidizing job. Theoretically, it is the most energetic oxidizing element available—but only as a gas or cryogenic liquid. When combined in a solid state, fluorine at present becomes one of the most unreactive materials in existence. This is the reason some ARPA contractors believe the program is more likely to result in a liquid propellant than the intended solid.

Regardless of the eventual outcome, contractors and ARPA officials agree that the results so far appear promising and justify continuation of the program. During the past year, the four companies holding the integrated ARPA research contracts have concentrated on defining their areas of attack, determining just which types of compounds looked most promising. Now that they know what to make, they are trying to develop syntheses for them.

In another year, some contractors say, they could conceivably have a new solid propellant compound. Then they will have to scale up output—from ½-gram to 100-gram quantities—to get enough propellant to test. Their work will end with the successful testing of a small quantity of a new solid propellant. As presently planned, it will not be up to the current ARPA contractors to prove that their new propellants can be produced in large quantities or that they will perform well in full-scale rockets.

NASA Budget

Washington—National Aeronautics and Space Administration will ask Congress for "something under a billion dollars total" for its Fiscal 1961 budget, Associate Administrator Richard E. Horner said last week.

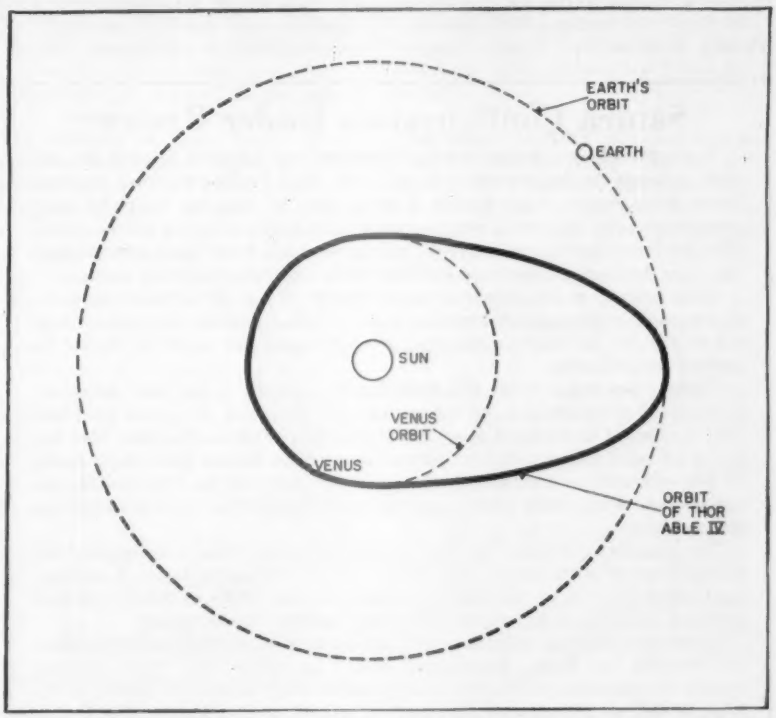
A supplemental request for Fiscal 1960 also was still being considered last week. A major consideration in both a supplemental and the Fiscal 1961 budgets is the cost of continuing the Saturn booster program.

Horner said the 1961 request will be between the half-billion asked in Fiscal 1960 and one billion. The actual figure is believed to be approximately $800 million (AW Nov. 16, p. 25). There has been speculation recently that the Fiscal 1961 request might run as high as $1.2 billion. Horner's comment leaves open the possibility that a supplement Fiscal 1960 request plus the Fiscal 1961 request of less than a billion might produce a total in the neighborhood of $1.2 billion.

Thor-Able IV interplanetary probe will travel around sun with "paddlewheel" arms extended for trapping solar energy.

First Details of Thor-Able IV Solar Satellite

National Aeronautics and Space Administration's Thor-Able IV interplanetary probe, projected for launch about Dec. 15 into a trajectory which will make it a satellite of the sun, will be approximately 26 in. in diameter and weigh 80-90 lb. Like Explorer VI earth satellite, it will carry four "paddlewheels" fitted with solar-energy cells. Thor-Able IV will not use Explorer VI's "propeller blade" units on surface to control the payload interior temperature (see p. 53) but will use a simpler, paint-pattern scheme on the surface to maintain an internal temperature value between 38F and 80F. Because it will come so much closer to the sun during its elliptical orbit than did Explorer VI, it is likely that the paddlewheel solar cells also will have to incorporate a heat protection scheme. Space phenomena will be telemetered on 378.21 mc. from payload to ground stations in the tracking chain. Contributing to the NASA-managed project is Air Force's Ballistic Missile Division, with its Thor intermediate range ballistic missile booster coupled to an Aerojet AJ10-101A second stage and Allegany Ballistics Laboratory X-248A4 third stage, and Space Technology Laboratories, which is building and integrating the instrumented paddlewheel payload. Weight limitations dictate that only one transmitter and a few scientific experiments can be carried. Thor first stage carries no guidance, only an autopilot, and first and third stages carry no tracking instrumentation.



Satellite will orbit the sun in an elliptical path, with closest approach to the sun in the vicinity of the orbital path of Venus, and its greatest distance from the sun in vicinity of the orbital path of earth. Perihelion will be about 66-67 million miles and aphelion about 93 million miles. Sun orbit will be about 300 days.

McElroy Outlines Airborne Alert Plans

By Craig Lewis

Washington—Neil H. McElroy outlined a composite strategic deterrent concept for the next four years which could include a Boeing B-52 airborne alert as he left the Defense Department last week to return to private industry.

McElroy revealed that the groundwork is currently being laid for an airborne alert capability during the critical 1961-63 missile gap period so that it will be available in case the Joint Chiefs of Staff decide such an alert is needed to shore up U. S. deterrent power during the years the Soviet Union has superior missile power. Funds have been allocated for training and equipment needed to make an airborne alert feasible.

McElroy discussed the U. S. strategic deterrent concept for the missile gap period at a press conference held shortly after the White House announced his long-expected resignation and after the President had awarded McElroy the Medal of Freedom. The former Defense Secretary left the Pentagon the same day his resignation was announced, and he is scheduled to return to Proctor & Gamble today to become chairman of the board after two years and two months in the Pentagon.

McElroy was replaced last week by Thomas S. Gates, Jr., former deputy secretary of defense. Gates, 53, a Philadelphia banker, has served in the Pentagon since 1953. He became undersecretary of the Navy in 1953 and later moved up as Navy secretary. He replaced the late Donald Quarles as deputy defense secretary last summer.

McElroy's last major job was to complete preparation of the military budget for Fiscal 1961. McElroy said the budget sent to the White House for presentation to Congress is designed to hold U. S. defense spending close to the $41 billion level. The total military budget, however, may be close to $43 billion next year since foreign military aid will be included for the first time.

Although he refused to discuss budget details, McElroy conceded that the Army Nike Zeus anti-ICBM system will not go into production during Fiscal 1961 but will continue with "very generous support of a research and development program." Other effects of the final budget decisions began to become apparent last week when USAF cut back its B-70 program (see page 26). McElroy said the Joint Chiefs have discussed the general adequacy of the budget, but that they will not be asked to sign a letter endorsing it this year as they were required to do last year (AW Mar. 16, p. 29).

McElroy said the U. S. strategic delivery capability is substantially higher than it was two years ago and that the limited war capability also has increased, primarily through deployment of tactical nuclear weapons. The retiring Defense Secretary repeated his earlier forecast that the U. S. and the Soviet Union would each have about 10 intercontinental ballistic missiles operational by the end of 1959. He said that, if "they build what they could build and if we build what we intend to build," Soviet missile capability will be superior in the 1961-63 period.

To counter this missile gap, the U. S. plans to maintain a composite deterrent force until Minuteman becomes operational in 1963. The bomber force of the Strategic Air Command is a key element in this composite force, McElroy said, and provisions are being made to prepare for a possible airborne alert to keep part of the B-52 force secure from destruction on the ground.

Alert preparation involves training of air crews and procurement of long lead-time items, such as engines, so that the crews will be ready and the equipment in storage if the Joint Chiefs of Staff decide such an alert is necessary. Some funds are available in the current budget for this preparation, and more money is allotted in the Fiscal 1961 budget.

McElroy pointed out that the life of the B-52 will be extended by the North American Hound Dog missile. This 500-mi.-range missile carries a nuclear warhead and can be launched from the B-52G and B-52H to destroy enemy defense installations and clear the way for bomber penetration of enemy territory. McElroy said the Hound Dog does not interfere with the bomb-carrying capacity of the B-52.

Discussing U. S. missile capability, McElroy said: "Today we are satisfied that the Convair Atlas is a proved weapon and are moving ahead vigorously to deploy them." He also said "it is intended that Titan will continue in the picture." The Polaris fleet ballistic missile submarine force was mentioned as another part of the composite deterrent force, and McElroy said the submarines will go on station at the rate of about one every four months after the first one becomes operational late next year. He said this scheduled Polaris buildup will continue "as far down the road as we can see."

While he described current ICBMs as important deterrent elements, McElroy cautioned against investing too heavily in first-generation weapons that might be quickly superseded by improved second-generation missiles. Future plans obviously depend heavily on successful development of Minuteman, and McElroy said the program is "re-

Saturn Configuration Under Review

Washington—Project Saturn technical committee was scheduled to meet late last week to discuss the upper stages to be used with the 1.5-million-lb. thrust clustered Saturn space engine. Some thought is being given to designing completely new upper stages rather than using existing rockets since great dependence will be placed upon the Saturn-boosted vehicles in the attempt to match Soviet space achievements, and stages designed specifically for use with Saturn might produce better results.

Initial meetings of the committee were held Nov. 27 and 28 to discuss the types of missions that Saturn-boosted vehicles might perform. Two-day meeting last week was to consider the numbers and types of upper stages that would be needed to perform those missions.

Whether new upper stages will be designed apparently is the most important question still to be settled in the Saturn program. Budget for the project for Fiscal 1961 is expected to remain at about the $140 million recommended some time ago by the Advanced Research Projects Agency. Competition for new upper stages would be time-consuming and require proving out of the new vehicles that resulted, but optimization of the whole vehicle might be worth the resulting extra investment in time and money.

The committee is advising the National Aeronautics and Space Administration on technical aspects of the project, and Advanced Research Projects Agency is continuing to administer the program until it is transferred from ARPA to NASA sometime next year. Actual work is going on at the Army Ballistic Missile Agency.

Chairman is Abe Silverstein, space flight development director for NASA. Members are Wernher von Braun, development director at ABMA; Abe Hyatt, assistant director for propulsion for NASA; George Sutton, chief scientist of ARPA; T. C. Muse of Defense Department's directorate of research and engineering; USAF Col. Norman C. Appold, who is in charge of NASA-ARPA relations for the Air Research and Development Command. Secretary is Eldon Hall of Hyatt's office. A Saturn task force also has been named to handle logistics problems.

President's Advanced Planning Views

Washington—President Eisenhower last week outlined his views of the mixed force concept and advanced weapons planning in reply to a question at a press conference on the eve of his departure to Europe. Following are the question and the President's reply:

• Charles H. Mohr, Time magazine—"Mr. President, this is a moment in history in which we have to maintain a large strategic capability in manned aircraft and, at the same time, paying for the increasingly expensive development of missiles capability; and also, an anti-missile defense capability.

"And I wonder if you could discuss and explain to us how, in such a moment in history, the defense budget does not need to rise but can stay relatively stable over a period of two or three years?"

• The President—"Well, I think that the first thing is this:

"Since you are going from one defense system, largely, to another, particularly in this matter of deterrent, there is an old saying—what is it—'Be not the first by which the new is tried, nor yet the last to lay the old aside.'

"Now, that's what we're doing. But we are, if you want to have a real, really expensive thing, stop everything now that we've been doing and then just put a tremendous hysterical urge about the business of getting something new.

"Now you will really have, to my mind, a bad answer and an expensive answer. But as we are finding that our Atlas is operational, and is operational, and it comes into this picture, it is only natural that there is shown less concern and less cost in the matter of developing newer and better and bigger airplanes, faster, higher flying, and so on.

"Now, we do not quit that entirely. As you know, the B-58, on a moderate program, is to be completed, and there is a very definite, there is an R&D program going on on one that's even bigger (apparently the B-70, see p. 26), so that we do not feel ourselves within just a matter of two or three or four years completely dependent upon the missile, until we've got these missiles perfected to the point where we think that the deterrent itself needs nothing else."

ceiving optimum funding" and the solid fuel missiles are expected to be in place in the calendar year 1963.

Although the composite delivery force is generally discussed as a means of filling the 1961-63 missile gap until Minuteman is operational, McElroy said that "we do not plan at that time to depend only on the Minuteman either." He said he thinks the bomber will be in the inventory "for quite some time to come."

British Industry Resists Group Edict

London—British aircraft industry is resisting pressure to regroup until the government defines its future policy, outlines its aircraft requirements and decides the scale of any British participation in supersonic aircraft and space programs.

The opinion still is widely held among leading companies that when it possesses this information, the industry should be left to decide a structure for itself, without government pressure.

Reliable sources maintain that the Minister of Aviation Duncan Sandys, in a recent fact-finding tour of major aircraft companies, was insisting on a 50% contraction of the aircraft industry of 120,000 workers, based on three major aircraft groups and two engine companies.

Envisaged by the Minister as the new groups were English Electric, Vickers and Hawker Siddeley, Bristol, and a consolidation of the Airco group (de Havilland, Hunting and Fairey). All other companies were expected to be absorbed later by these groups.

Regrouping is disliked by the industry for a wide range of reasons and to bring pressure to bear, Sandys is reported to have stopped the issuance of contracts in many categories until some reshaping has been agreed. According to one source, a contract affected by the clamp is the Fairey Rotodyne. Another could be the Hovercraft.

De Havilland is not anxious to close the Airco links because outside of the Airco 121 airliner, both Hunting and de Havilland have completed rival designs for jet feeder aircraft. The merger between Bristol and Hawker Siddeley appears to be stymied by financial factors associated with each.

Companies most hostile to any regrouping were Handley Page and Blackburn and General Aircraft Co., which probably accounts for their absence from the three-group structure.

News Digest

Martin Co. last week reported additional purchase of stock of General Precision Equipment Corp., adding to the more than 10% of General Precision stock acquired this summer, and continuing Martin's trend out of the aircraft business (AW Nov. 9, p. 29). Ownership of common stock has increased from 140,300 shares to 183,700 shares, equal to 16.3% of total common outstanding.

Sikorsky Aircraft's turbine-powered amphibious S-62 demonstrator helicopter nosed over during a simulated autorotative wheels-down landing on the Housatonic River, adjacent to the company's Stratford, Conn., plant. No injuries were sustained by the crew. Helicopter, which broke in two forward of tail pylon (just aft of where hull rises rearward out of water), suffered water and mud damage to its interior but is not a total loss.

Allegheny Airlines Martin 202 crashed last week into a mountainside near Williamsport, Pa., during an approach course killing 25 passengers and crewmembers aboard. One passenger survived. According to observers at the airport, the aircraft missed its initial approach during a light snow and circled to line up for a second approach which brought it over the mountain ranges near Williamsport. It was during this maneuver that the accident occurred.

British government last week declined to sell 17 Hawker Hunter jet fighters to Cuba (AW Oct. 5, p. 131) as part of Britain's policy to restrict sale of arms in the Caribbean area. Cuba wanted to trade Hawker Sea Furies for the jets.

Air Force accepted the first operational Convair B-58 last week for the Strategic Air Command inventory. This first production model was the 31st B-58 built and is an improved version of the earlier test models. First 30 B-58s went into flight test programs, but 13 of them will be converted to operational configuration and go into squadron service.

Hiller X-18 VTOL has made its first flight at Edwards AFB, Calif., with the tilt-wing fixed in a near-horizontal position (AW Nov. 16, p. 39). Flight lasted 20 min.

USAF-General Electric Co. experiment aimed at obtaining the first color movies from space (AW Nov. 23, p. 23) failed last week when a GE nose cone carrying a 16-mm. color camera and launched by a USAF-Douglas Thor was not recovered.

Kaman Aircraft Corp. will attempt to break the Soviet helicopter altitude record (AW Mar. 30, p. 41) Dec. 9 using its USAF H-43B turbine helicopter.

Jets Spur Transatlantic Passenger Rise

Airlines foresee one-third increase in seats next season, as 12 carriers phase jets into service.

By Glenn Garrison

New York—Airline capacity on the North Atlantic, which rose little last summer as most carriers waited for their jets, is expected to increase by about one-third next season when 12 airlines will be offering jet service.

Most carriers reported good results for the 1959 peak season although many were holding the line in seat capacity, as predicted by AVIATION WEEK (May 4, p. 40). Scheduled International Air Transport Assn. airlines offered 956,973 seats on the route during the June-through-September period, an increase of 4% over the same period of 1958.

Passengers carried totaled 693,976, an increase of 12%. By way of contrast, capacity increased 40% in the summer of 1958 over the summer of 1957 and the passenger increase was 33%. Many carriers in 1958 were adding new units of their late-model piston fleets.

For the first nine months of 1959, the passenger total was up 13% to 1,091,478, topping the million mark for the first time so early in the year. Capacity for the nine months rose 5% to 1,626,505 seats. Over-all passenger load factor for the four-month summer period of 1959 was 73%, up from 68% the previous season.

First-class passengers carried in the 1959 summer period totaled 121,457. The economy class total was 544,169 and the vanishing transatlantic tourist-class passenger accounted for 28,350 occupied seats.

Transitional Period

Only Pan American World Airways and British Overseas Airways Corp. had jets in their transatlantic fleets during the entire summer 1959 period, but only four of the 16 IATA airlines on the run will lack jets next summer. Most of the new Douglas DC-8s and Boeing 707-320s and 420s will begin appearing in service next spring. Jets will dominate the North Atlantic next summer, and the carriers face this transitional period with some uncertainties:

• **Filling the expanded** capacity, which an AVIATION WEEK survey indicates may total 1,274,000 seats next summer, will call for strenuous competitive sales efforts to find the market. Burgeoning prosperity on both sides of the Atlantic is a hopeful omen. The jets themselves, with their new standards of comfortable flight and their time-chopping speeds, should stimulate new sources of business. But whether all carriers will be able to keep their expensive new jets busy enough and full enough to make them pay during the first big jet season is a question everyone wishes he could answer. Forecasts to AVIATION WEEK of traffic increases ranged from 15% on up to a doubling of the business.

• **Rate situation** still is uncertain because of the breakdown of IATA traffic conference negotiations at Honolulu (AW Oct. 13, p. 40). As things now stand, there will be no official IATA fare or other agreements in effect on the Atlantic after Apr. 1. However, most airline officials feel that no open-rate situation will come about. Either the carriers will hold a special meeting, probably early next year, and come up with a transatlantic IATA agreement, or the status quo will probably obtain on an unofficial basis. Consensus is that a special meeting will be held, with little change in fares except that the jet surcharge probably will be eliminated.

• **Air Union,** the cooperative program among four European operators, would change the competitive balance if its effects were felt next year. But it seems unlikely that Air Union's plans, which are still in an early stage of development, will be significant on the route as far as 1960 is concerned. Its members—Air France, Alitalia, Sabena and Lufthansa—are proceeding with their individual, competitive sales drives for next year's transatlantic business.

Summer Trend

The past summer's over-all trend toward holding the capacity close to previous levels was by no means uniform, and the picture varied considerably among individual carriers. The two operators of jets during the period, for example, took different approaches, with Pan American cutting capacity and BOAC increasing capacity substantially. Here are examples of individual results for the June through September, 1959, period and tentative outlooks for 1960:

• **Pan American** achieved a spectacular load factor of 86% for the period, cutting its capacity by 9% and yet carrying 14% more passengers than during the same four months of 1958. Load factor for the 1958 period was 69%. Seats offered in the 1959 period totaled 149,359, split 74,747 eastbound and 74,612 westbound. Passengers totaled 128,768—62,672 eastbound and 66,096 westbound. The airline offered 55% of its seats in Boeing 707-120 jet equipment during the period. Next summer, Pan American expects to increase its capacity by 15-20% on the route, with jet service comprising about 80% of the total. The carrier plans to operate 40-45 transatlantic round trips a week at the peak of summer 1960, exclusive of the West Coast-Europe polar route. Its Boeing 707-320s, already phasing in to the North Atlantic operation as well as on other routes, will probably be augmented by other jet equipment—leased Douglas DC-8s from National Airlines under Pan American's and National's reciprocal agreement, and/or Pan American's own DC-8s, which will start arriving next spring for assignment to the carrier's divisions. Pan American's estimate of the market expansion next year is 15% for the North Atlantic. At the peak of the season, when space is usually hard to get, the airline believes next summer's traffic will provide a demand for piston as well as jet seats. Pan American's DC-8s, in a typical configuration, will seat 36 first class and 87 economy passengers, a total of 123.

• **BOAC took a different** course from Pan American's last summer, increasing capacity by 53% and carrying 42% more passengers for a total of 162,925 seats and 112,647 passengers during the period. Figures include BOAC's transatlantic operation from Canada. Load factor was 69%, a drop from 75% during the same 1958 period. The British carrier provided 30% of its capacity in its Comet 4 jets and also operated the turboprop Bristol Britannia and the Douglas DC-7C. The Comets were used in de luxe and first class and first and economy configurations, with tourist and economy passengers carried in the other equipment. Comet load factor for the period was "slightly under 90%," BOAC said. First-class passengers in all equipment for the period totaled 24,355 and first-class seats totaled 34,965, for a first-

First Lufthansa Boeing 707-420 Rolls Out

First Boeing 707-420 Intercontinental jet transport for Lufthansa German Airlines is rolled out from the Boeing Airplane Co. plant at Renton, Wash. Airline has ordered four Intercontinentals; plane will make its first flight this month and will be delivered late in January. Powerplants are four Rolls-Royce Conway bypass engines.

class load factor of 69%. Although most airlines had dropped their tourist-class accommodations by last summer, BOAC offered 29,262 seats in this class, carried 18,482 tourist passengers. Economy capacity was 98,698 seats and passengers totaled 69,810. BOAC plans to offer about 40% more peak capacity next summer than during the peak of 1959.

Its Rolls-Royce Conway-powered Boeing 707-420s will be phased onto the route beginning next January, and Comets will be phased off the run within a week of the Boeing jet transport inaugurals.

Promising Outlook

Outlook for filling the scheduled capacity is "promising" in BOAC's view, and the carrier already has bookings which indicate a 500% increase in charter business during the year. Charters will be flown in all types of equipment including the new jets.

Trans World Airlines, which has just inaugurated its first transatlantic jet service with Boeing 707-320s (AW Nov. 30, p. 41), cut back its summer 1959 capacity to 107,109 seats, compared with 138,278 the previous summer. Passengers totaled 76,561, down from 87,723 during the same period of 1958. Mainstay of TWA's transatlantic fleet last summer was the Lockheed 1649A Constellation. During the period July 3 through Sept. 26 of 1959, TWA offered a peak of 45 round trips a week.

Next summer, the airline expects a peak of only 40 weekly round trips on the North Atlantic, but 35 of them will be in the big jets and peak weekly capacity is expected to total 11,790 seats in both directions, compared with 6,922 seats last summer. The other five round trips will be flown in 1649As and these aircraft also will connect with the jets at overseas gateways. TWA forecasts a passenger increase of 50% for the year 1960.

KLM Increase

KLM Royal Dutch Airlines increased its traffic by 21% to 64,977 passengers while its capacity went up only 13% to 91,296 seats. The carrier expects a 15% increase in both seats and traffic for next season. First transatlantic jet service with DC-8s is planned Apr. 1 with a daily round trip between New York and Amsterdam.

From June 1 on, KLM expects to schedule two daily DC-8 flights and two daily DC-7C flights, the latter carrying economy and first class seats and berths. The carrier has moved from fifth place in transatlantic passenger volume to fo ch place, on the basis of summer 1959 figures.

Scandinavian Airlines System reduced its transatlantic capacity very slightly during the four-month period from 83,644 to 83,016 seats, showed a tiny traffic increase from 58,237 passengers in the summer of 1958 to 58,443 passengers last summer. Next year it will step up capacity by 30-35%, according to present tentative plans. Like Pan American, SAS believes the industry can expect an increase of about 15% in passenger traffic.

The Scandinavian carrier plans to make the most of its Sud Caravelle jet connections with its transatlantic DC-8s. With this equipment combination as one of its prime sales tools, SAS expressed confidence it can achieve high load factors with its transatlantic jets, and also expects to fill enough piston seats to make its DC-7C flights profitable.

It will start phasing jets onto the Atlantic in April and expects its piston services to end around the middle of next September.

By July, SAS may be offering 18 weekly jet and seven weekly piston schedules.

Air France offered 69,361 seats, up 10% from the 1958 period. Traffic increased 17% to 50,094 passengers. Of the 1959 capacity, 57,823 were in economy seating. The airline estimates a capacity increase next season of 60%. Boeing 707-320 service is scheduled to begin from New York Jan. 25 with daily flights, and by next summer peak all-jet service is planned with three daily flights.

By Apr. 1, jet schedules will fly the polar route from Los Angeles via Montreal, and Chicago will be served by Apr. 15. At that time, all of Air France's transatlantic services will be jet.

The carrier's 320s will carry 32 de luxe and 108 economy passengers.

Hard Sell

Other jet plans include Paris-Anchorage-Tokyo service beginning Feb. 2 with the 320. Like SAS, Air France will sell its Boeing-Caravelle combination hard. Air France now has six Caravelles flying, expects its order of 24 to be completed by the end of next year. Not long after, the carrier plans to be serving 81 cities with its jets: 42 with the Caravelle and 39 with its 17 Boeings.

Lufthansa German Airlines boosted summer 1959 capacity by 24% over the previous season, carried 23% more passengers. Totals were 47,078 seats

and 33,661 passengers during the 1959 period. Lufthansa's first Boeing 707-420 is scheduled to go into transatlantic service Apr. 1 from New York and Chicago, and polar jet service from San Francisco beginning May 10.

The airline will have three of the big jets in operation next summer and four next fall. It plans to operate three weekly flights out of Chicago, seven out of New York and two out of San Francisco at the peak, and to add flights with 1649A equipment when necessary.

Sabena Belgian World Airlines cut back capacity 11% following a special expansion the year before in connection with the Brussels Fair. Seats during the 1959 period totaled 50,510 and 29,966 passengers were carried, a drop of 18% from the previous summer. Sabena's 707-320s are scheduled to appear in North Atlantic service Feb. 15 with four weekly round trips, which will be supplemented by three weekly DC-7C flights. The airline expects to schedule 14 weekly jet flights at the peak.

Swissair will step up its transatlantic capacity drastically as its DC-8s begin phasing in, with first service tentatively scheduled for May 6 with three weekly New York-Zurich schedules. Nine to 12 weekly schedules are planned for next year's peak when the carrier's three-plane fleet has been delivered.

Swissair will be the third carrier to tie transatlantic jets in with its own Caravelle jet schedules (AW Nov. 23, p. 43). During the four-month period of 1959, Swissair's capacity was up only slightly to 28,631 seats, compared with 27,942 during the 1958 period. Passenger total rose from 20,465 to 21,874.

Trans-Canada Air Lines plans to put its Conway-powered DC-8 on transcontinental domestic service Mar. 1 and to offer DC-8 service on the North Atlantic beginning Apr. 1. Last summer, the airline offered 38,333 seats and carried 30,899 passengers for a load factor of 81%. Totals for the 1958 period were 37,010 seats, 29,245 passengers, load factor 79%.

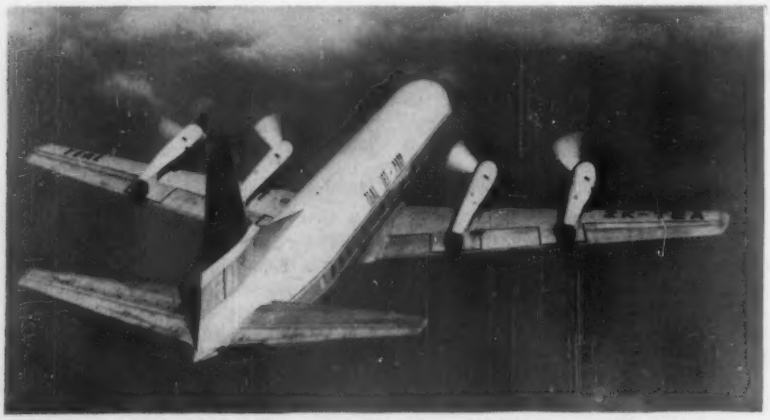
Qantas Empire Airways introduced transatlantic Boeing 707-120 jet service in September as part of its new round-the-world jet service. With two weekly round trips and no originating base on the Atlantic shores, Qantas carries a very small percentage of the transatlantic traffic. If frequencies are stepped up next year, they will still be a part of the global service.

Four of the 16 IATA airlines on the North Atlantic will face next summer without jet equipment. Irish Air Lines, which entered the transatlantic picture in May, 1958, with leased Lockheed 1049H equipment, expects delivery of its first beefed-up Boeing 720 next fall. In the meantime, it will continue to offer an all-economy service on the run.

Canadian Pacific Airlines, which has been flying Britannias four times a week from Vancouver, B. C., to Amsterdam and DC-6Bs from Montreal to Santa Maria, Lisbon and Madrid, has ordered four Conway-powered DC-8s and expects the first delivery in December, 1960. During the interim, the Canadian carrier will get in some spadework on a newly-won route to Rome, with first schedules set for Mar. 1. Britannias will fly this route, which is an extension from Lisbon.

Iberia Airlines of Spain has ordered three DC-8s and hopes to get the first in late 1960. The carrier operated four weekly Lockheed Super G Constellation flights on the North Atlantic last summer, as it did in 1958. It plans no increase next year but is stepping up promotional and sales plans to prepare for the jet transport competition.

El Al Israel Airlines has announced it will buy four jets of U.S. manufacture in 1962. In the meantime, it will rely on its Britannias which carried 9,261 passengers last summer, against 12,618 passengers in the same period of 1958. Capacity totals were 18,770 seats in summer 1959, and 12,748 seats the previous period. El Al feels it will hold its own with its direct service to Israel and reports bookings better than last year's. Its six weekly flights may be increased by one next summer.



First TEAL Electra Makes Delivery Flight

First Model 188C Lockheed Electra turboprop transport for Tasman Empire Airways, Ltd. (TEAL) leaves Burbank, Calif., on delivery flight to Auckland, New Zealand. TEAL Electra carries 85 passengers. Plane, one of three Electras ordered, will start service this month; two others will be delivered by year-end.

Flying Tiger Seeks Swing-Tail Tariff

Los Angeles—Research program to lead toward lowering air freight rates to competitive levels with many truck and rail freight rates is being conducted by Flying Tiger Line and Canadair, Ltd. The joint sales-research program will have a supporting budget of approximately $200,000 for the next year.

Flying Tiger, with its fleet of 10 Canadair CL-44D-4s (AW Sept. 7, p. 38), is seeking a tariff for the swing-tail turboprop freighter which will effect a breakthrough into freight rate areas on an average of 30 to 40% under today's existing rates.

Canadair and Flying Tiger believe that rates as low as 6 cents a ton mile are possible with the CL-44D-4 and that an average rate of approximately 13 to 14 cents, compared with the existing average of 18-19 cents, can be achieved. Previous studies have indicated that such rate levels should create an air freight market from 7 to 10 times today's volume.

The research program has two phases:

- **Analyze in detail** the characteristics of cargo presently being hauled by Flying Tiger.
- **Identify, locate, measure** and determine characteristics of commodities which have air potential and can move by air rather than surface.

Phase I of the program has been completed and work on Phase II is well under way, according to Flying Tiger. Included in Phase II are studies of value, volume movement, weight, dimensions, tariffs, density, origin and destination, directional movement and distribution costs of potential air cargo.

For several months, Flying Tiger has had a research staff working under the direction of Robert L. Brunner, manager of the airline's rates and tariff department. Keith A. Miller, manager of Canadair's sales research staff, will join Brunner for the study. Stanley Brewer, professor of transportation for the University of Washington, and Roger B. Ulvestad, professor of transportation for the University of California at Los Angeles, have been retained as consultants.

Boeing 720 Medium-Range Jet Makes First Flight

Boeing 720 medium-range jet transport (AW Nov. 16, p. 40), making its first flight from Renton Municipal Airport, Wash., is the first of 18 for United Air Lines. Aircraft is powered by four Pratt & Whitney JT3C-7 engines, each developing 12,000 lb. thrust. Aircraft will be delivered to United next April; 25 have been ordered by American Airlines and three by Irish Air Lines. Plane is 8 ft. 4 in. shorter than 707-120 and 45,000 lb. lighter. Leading edge of the wing has been extended to increase sweep between the fuselage and inboard engine and add to low-speed wing lift.

ICAO Studying Traffic Data Exchange

By Ford Eastman

Washington—International airlines' long-standing controversy over the exchange of passenger origination and destination reports is building to a climax with a concerted effort to bridge one of the widest gaps in world airline relations.

A move to try and solve the problem is being undertaken through the International Civil Aviation Organization which has appointed an 11-nation panel to study the feasibility of a multilateral origination and destination exchange, review the background of the dispute and submit proposals for a workable agreement. The panel's next meeting is scheduled for May.

Difficult Task

The task of recommending a plan that would be acceptable to all the airlines concerned will be difficult. Flag carriers from the Scandinavian countries, the Netherlands and Belgium are strongly opposed to the exchange. Others, including those of the United Kingdom, Brazil and the U.S., are equally strong in their support.

Airlines have exchanged traffic figures in the past, but this was abandoned about six years ago on grounds that they served no useful purpose, at least partially because many carriers failed to respond directly to all the information requested. The U.S. was one of the nations that voted for discontinuance of the reports.

The type of reports now sought by proponents of the exchange is a true origination and destination report based upon the passenger's ticket that would show where he first boarded the airline and the route taken to his destination. This, they say, would be advantageous to all airlines in future planning for the establishment of sales offices, flight frequencies, schedules and routes.

Those opposed to the plan argue that such reports would be time consuming and costly and would not be of any help in airline operations. However, these carriers did indicate that they would agree to furnish reports on the number of passengers traveling between their respective countries and other nations—a plan similar to the earlier reports that were discontinued.

Some of the foreign carriers opposed to the exchange also have indicated that they might agree to exchange origination and destination reports with the U.S. if, in return, the U.S. would agree to additional route concessions.

This is strongly opposed by most American flag carriers who contend that foreign airlines already have access to a greater potential market in the U.S. than U.S. carriers have received in return. U.S. international carriers not affected by the granting of additional route concessions to a foreign airline might be inclined to support this proposal in order to get an agreement for an exchange of the reports.

Under the ICAO program, however, this type of bargaining would not be an issue, and any agreement reached would have to be made solely on the merits of the exchange and the ability of the panel members to clear any doubts as to its purpose.

U. S. Belief

U.S. flag carriers contend that the real opposition to the exchange of origination and destination reports based on tickets, and not airline manifests, is that it would reveal any violations of the capacity clauses incorporated in bilateral air agreements.

The capacity clauses in a Bermuda-type agreement provide that the air services made available to the public by the airlines designated to operate between the two countries shall bear a close relationship to the requirements of the public for such services. This is termed Third and Fourth Freedom traffic.

At the same time, the Bermuda principles provide that the airlines have a right to embark or disembark international traffic destined for, and coming

Air France–First European Airline to Fly Giant Boeing 707 Intercontinental Jets Across the Atlantic!

Here's another Air France "first" for the record! Soon Air France's Boeing 707 Intercontinental Jet will touch down at Orly Field after a 6½-hour non-stop flight from New York. This flight will mark the beginning of the world's first "jet-to-jet" service—Intercontinental jets non-stop daily to Paris, Caravelle jets from Paris to all Europe, Africa and the Middle East.

Air France is no stranger to the pages of aviation history. As early as 40 years ago, Lucien Bossoutrot made the first international commercial flight between France and England. Similar historic first flights include the first crossing of the South Atlantic, the Andes, and the first scheduled Far East service.

The inauguration of transatlantic jet service demonstrates the forward steps that have helped make Air France the world's largest airline, with the world's most personal jet service.

AIR FRANCE JET

WORLD'S FASTEST JETLINER / WORLD'S LARGEST AIRLINE

from, third countries at points on routes specified in the agreement so long as service provided by the local or regional airlines in the area are taken into account. This is known as Fifth Freedom traffic and is generally considered a secondary objective in establishing the route, but it is one of the biggest problems confronting international airlines.

More recently, however, a new angle has been injected into the dispute, primarily by European carriers, who are proposing what they term Sixth Freedom traffic. This, they say, is traffic that is brought through an airline's country en route to a second country. For example, a passenger bound for Paris who is boarded in Mexico by Pan American World Airways and taken to New York en route to Paris would be Sixth Freedom from Mexico to New York, according to the European airlines, and the same as Third and Fourth Freedom traffic from New York to Paris. This would permit carriers to sidestep the Fifth Freedom clauses restricting the number of passengers that can be carried.

U.S. carriers do not agree with this interpretation. They maintain that traffic originating in the U.S. and bound for France or vice versa is Third and Fourth Freedom traffic for which the U.S. and French carriers can compete. All other traffic not originating in or destined for either of the two countries is Fifth Freedom, they say.

Traffic Flow

True origination and destination reports would reveal the amount of traffic traveling between the two countries as well as the amount of traffic going to or coming from a third country. U.S. flag carriers say they have long suspected that a major portion of the traffic of some foreign airlines is coming from or going to a third country in violation of the capacity clause. U.S. carriers also have been charged with Fifth Freedom traffic violations. Airline manifests or even immigration statistics, however, would not necessarily show a violation.

Supporters of the origination and destination report exchange feel that, while the reports would reveal the type of traffic being carried by airlines, there are a number of more important reasons for an agreement on this issue. One of the biggest problems, these carriers contend, is the lack of understanding of the uses that could be made of the reports.

Domestically, where origination and destination reports are exchanged, they are used to support requests for additional service between pairs of points and in forecasting traffic growth and long range route and service needs. The benefits of an exchange of figures that all international airlines could expect are currently being prepared by a joint industry-government group in a form of a report to be submitted at the May meeting of the ICAO 11-nation panel.

U.S. representative on the ICAO panel is Warner H. Hord, chief of the Office of Carrier Accounts and Statistics of the Civil Aeronautics Board. Other nations represented on the panel are Argentina, Brazil, Denmark, France, Sweden, the United Kingdom, Spain, the Netherlands, Switzerland and Canada.

707-320s Improve Nonstop Capability

By William H. Gregory

London—Boeing 707-320 series Intercontinental jet transports are crossing the Atlantic westbound nonstop 75-80% of the time and operators report the airplane's range capability is not in question on the trips which require a fuel stop.

Below-minimum weather at destinations is the prime cause of unscheduled stops. However, a Federal Aviation Agency requirement for increased rotation speeds on takeoff for the airplane (AW Sept. 14, p. 49) has meant using more runway sometimes and also has affected the nonstop performance.

Takeoff speeds have since been recertified by FAA and the final increases are 3-5% instead of the 7% interim figure.

Trans World Airlines' Flight 701 which left here with a press group returning after the inaugural flight to Europe (AW Nov. 30, p. 41) was a good example of how the airplane will operate the westbound transatlantic route in winter conditions.

First 707-321

The airplane, serial No. N761TW and powered by four Pratt & Whitney JT4A-3 turbojets, is the first of the three of TWA's, 707-331s delivered so far. It carried 28 first-class passengers, 89 economy, three pilots, flight engineer, navigator, three pursers and two stewardesses.

Because the length of the takeoff runway 28L at London Airport is only 9,576 ft. and because of the FAA rotation speed requirement, the maximum allowable gross weight of the aircraft was reduced from 302,000 lb. to 290,000 lb.

Actual takeoff gross was 286,027 lb. with a fuel load of 124,400 lb., about 15,000 lb. less than the 140,954 lb. allowable. Since headwinds were forecast to exceed 100 kt. on the great circle route to New York, a stop was planned at Gander and the fuel load reduced slightly more than necessary to meet landing weight requirements at Gander without wasting fuel.

The 45-sec. takeoff required an estimated 7,500 ft. of runway before liftoff. Nose was rotated at 155 kt. and the airplane was airborne at 164 kt.

Cruise Altitude

Initial cruising altitude was 36,000 ft., later raised to 39,000. True air speed was 470 kt. Actual track selected was about 100 mi. north of the great circle course in hope that the actual headwinds would be less than forecast.

This possibility turned into actuality. Ground speed on the London-Gander stage averaged 408 kt., making the average headwind component 62 kt. Since Gander weather was deteriorating and New York and Boston were open, the flight elected to eliminate the Gander stop and continue to New York International Airport at Idlewild with Boston as alternate even though increased headwinds were forecast.

Ground speed dropped to 330-335 kt., indicating a 130 kt. headwind component. Several modest power reductions were made reducing true air speed to 465 kt. or less between Gander and Idlewild to save fuel, which was averaging about 12,000-lb./hr.

The flight landed with 10,000-11,000 lb. fuel aboard at Idlewild in 8 hr. 13 min. from London—takeoff to touchdown.

Fuel Stop

In its first week of 331 operation, one of TWA's three westbound transatlantic flights stopped at Gander for fuel. This flight, the first one westbound with the larger airplane, met the combination of Idlewild closed by weather and the necessity of using Pittsburgh as an alternate, which would have required fuel on board at New York of 34,000 lb.

In contrast, the first eastbound flight which opened the 331 service took off from Idlewild at 294,000 lb. gross and with 127,000 lb. fuel, a 51-sec. takeoff using 8,400 ft. of runway 13's 11,000 ft. At a cruising altitude of 33,000 ft. the airplane cruised at 485 kt. TAS, or a ground speed of 535 kt. New York-London flight time, takeoff to touchdown, was 6 hr. 8 min.

Pan American World Airways, which put the long-range Boeing into service first, has been operating its 707-321s in scheduled transatlantic service since

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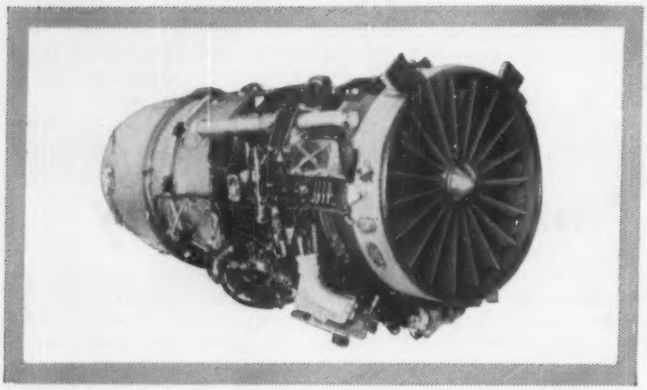
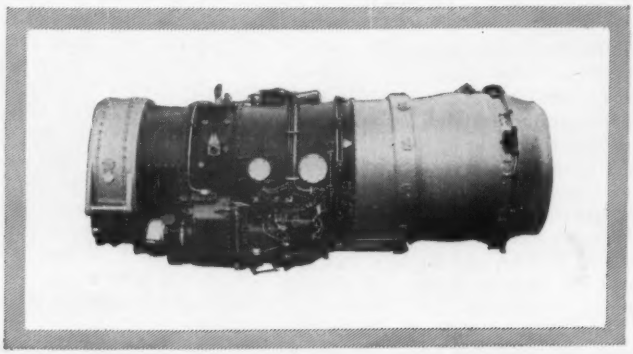
are now flying in Boeing 707-420 and Douglas DC-8 jet airliners

The by-pass or turbo-fan principle proved by the Conway is now generally accepted as the correct formula for all high speed subsonic jet transports.



Conway by-pass jets for civil use will enter service in 1960 at 17,500 lb. guaranteed minimum thrust. The Civil Conway is being developed to powers over 20,000 lb. thrust with improved fuel consumption, and will power the Vickers VC.10.

The RB. 141 family of by-pass jets (10,000 lb. to 17,500 lb. thrust) have been designed to give the best possible operating economics for jet transport aircraft. The RB.141 of 14,300 lb. thrust will power later versions of the Sud-Aviation Caravelle and the RB.163 of 10,100 lb. thrust has been chosen to power the Airco DH.121.



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First Eastern DC-8 Jet Transport Rolled Out

Eastern Air Lines' first Douglas DC-8 jet transport, equipped with Pratt & Whitney J75 engines, nears completion outside the Douglas plant at Long Beach, Calif. The airline plans to put its first DC-8 schedules on the New York-Miami run in mid-January, 1960, to meet jet competition from two other carriers. Eastern does not plan to use water injection with the J75s.

Oct. 10. Pan American's nonstop record:

• **Westbound.** London-Idlewild, 17 out of 22 flights nonstop; Paris-Idlewild, 15 out of 20 flights nonstop.

• **Eastbound.** Idlewild-London, 21 out of 22 flights nonstop; Idlewild-Paris, 16 out of 18 nonstop.

Pan American said the lengthening of the London runways by 1961 and the elimination of the 7% rotation speed penalty should help the situation on this route. Pan American is operating again at Orly Field in Paris, where runway length of 10,800 ft. is available.

Though winter winds will undoubtedly not show any improvement—those encountered on the TWA flight were higher than normal for this season—Pan American believes it may benefit on the balance from colder temperatures as far as fuel load is concerned. Next summer might be a problem at London, however.

Pan American says payloads have not suffered and one of the early 321 flights carried what was reported as a record payload of 36,800 lb. on a commercial scheduled flight.

Pan American says it has been able to operate the airplane at maximum economy cruise of Mach .82 with a fuel consumption of 2,100 gph. or about the same as the 12,000 lb./hr. noted on the TWA trip. This makes for a London-New York schedule of 7 hr. 55 min. flight time, which allows for unfavorable winds, and Pan American says it has been operating successfully within this schedule.

Pan American has 12 of the 321s, six in the Atlantic Division, four in the Pacific and two not assigned and which are now in Miami for modifications. The Atlantic airplanes are operating a New York-London and a New York-Paris-Rome schedule.

TWA has 12 of the 331s on order. Nine will be used in New York-London-Frankfurt and New York-Paris-Rome schedules. The three others are unassigned now, but might be used in service to Spain or Greece and beyond.

Now operating three flights weekly—New York-London-Frankfurt and New York-Paris—TWA will go to daily schedules New York-Paris-Rome Jan. 10 and to New York-London-Frankfurt Jan. 17. TWA will make available one airplane of this group to Northeast Airlines six days a week, beginning Dec. 17, but unlike the Pan American-National lease exchange, this will continue through the summer.

Summer schedules call for two daily round trip flights on each of the two routes beginning June 1. A typical schedule calls for Flight 800 to leave Idlewild at 7:30 p.m. and arrive Rome at 10:15 the following morning (zone time). The flight turns around as Flight 801, leaves Rome at 2:15 p.m. and is scheduled to arrive Idlewild at 7:40 p.m.

Integrating the schedules with the Northeast lease will not mean any close timing problems. Even with only the four airplanes TWA will have to carry out the two-daily-flight schedule in January, TWA will have two airplanes laying over from arrival one night until departure the next. TWA will give Northeast one airplane in the morning for a flight leaving for Miami at 9:30 a.m. and returning at 2:30 p.m.

The London and Frankfurt route will become all-jet but the Jetstream will be used to supplement the Paris routes. The airline reports that its jet transatlantic flights are already booked 50% for next June, indicating next summer may be a big one for transatlantic operators with jet equipment (see p. 36).

TWA and Sir Frank

British newspapers are miffed at BOAC for letting Trans World Airlines give Sir Frank Whittle, Britain's pioneer in development of the turbojet engine, his first jet transport flight. Sir Frank was guest of TWA on its first London-New York Boeing 707-321 flight.

The Evening Standard said Sir Frank had once asked BOAC to go along on a de Havilland Comet proving flight, but was refused. The paper quoted a BOAC spokesman as saying:

"'Sir Frank ceased to be our jet adviser six or seven years ago. I couldn't possibly check if he asked to make a flight before then. And so far as I know he hasn't asked us since.'"

The paper added:

"Wise in the ways of publicity, TWA didn't wait to be asked."

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FAA Sets Pilot Age Limit, Tightens Rules

By Robert H. Cook

Washington—Federal Aviation Agency last week issued a mandate requiring airline pilots to retire at the age of 60 plus new regulations calling for FAA approval of airline training programs and tighter copilot qualifications in a move expected to touch off a new round of labor-management disputes that could have far-reaching effects.

Three-way dissension between the FAA, the airlines and the Air Line Pilots Assn. (AW Oct. 5, p. 36) could become even more intense, depending upon the outcome of a public hearing scheduled by the agency for Jan. 7 on a proposed regulation that would limit jet transitional training to airline pilots under the age of 55.

FAA's assertions that it formulated the new regulations in an effort to improve flight safety have drawn conflicting viewpoints from both the pilots and management. The airlines agree with the mandatory retirement age ruling but join with ALPA in opposing the proposed jet training age restrictions as having little bearing on safety and as being too costly to implement. At the same time, the pilots' union is backing FAA's stand on training regulations, which it has sought for some time, and disagrees with company contentions that this issue is too costly and unnecessary in the interest of safety.

As outlined by the Federal Aviation Agency, the new regulations require these measures:

- **Establishment of age 60** as the mandatory retirement age for airline pilots, effective next Mar. 15.
- **Approval of all airline training** programs by FAA.
- **More comprehensive training** for airline copilots.
- **Proficiency checks** for copilots every 12 months under the direction of either FAA or a designated company check pilot.

Training regulations will become effective on Jan. 1, 1961, in order to provide the carriers sufficient time to obtain approval of their training programs and to qualify copilots under the new regulations. Airlines must submit their training programs for agency approval by next July 1.

Announcement of the automatic retirement age brought a sharply worded protest from ALPA which said it intends to challenge the ruling in the federal courts by seeking an immediate injunction against the action, which it termed part of the "czarist" powers of the FAA. An ALPA spokesman also said the extent of the agency's authority to issue such rulings should be investigated and defined by the next session of Congress.

Attacking the age regulation as "arbitrary and capricious," ALPA repeated earlier claims that there is no medical basis for such action and charged that FAA had refused to permit the pilots' union to examine the evidence upon which the regulation was formulated and also had refused to hold a public hearing on the matter.

ALPA said the "discriminatory" age had been "picked out of a hat," has no bearing on flight safety and is "strictly an industrial relations program." The union also contended that FAA's stand is "plainly at odds" with the over-all philosophy of government studies on the relationship between age and ability. ALPA said this opinion also has been expressed in letters it has received from several senators and congressmen, who, the union said, indicated that the FAA plan is unsound and contrary to public policy.

Wage Demands

Industry observers believe final outcome of all the new regulations, plus the proposed transition age limitation, is almost certain to trigger a new series of wage demands by the pilots who estimate their members will lose earnings and fringe benefits of $200,000 a year from the age restriction on jet training. Combined with possible union demands for a lowering of monthly jet flight hours, which would require more flight personnel, the addition of third pilots by many carriers and increased training costs, the group of regulations could result in demand for additional fare increases by the carriers who now are awaiting a final decision from the Civil Aeronautics Board in the General Passenger Fare Investigation. The airlines say training costs will jump by $28 million per year.

Issuance of the retirement age regulation, the Federal Aviation Agency said, is based upon medical facts that sudden incapacitation due primarily to heart attacks and strokes become statistically more frequent in any age group approaching 60 and cannot be predicted on an individual basis by prior medical examinations.

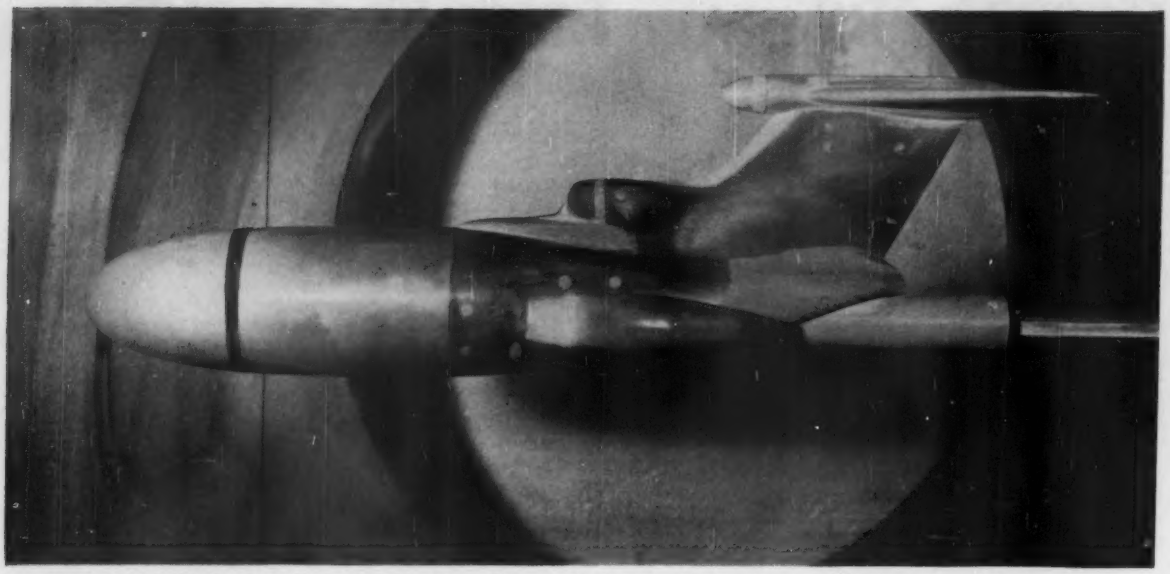
While it has not been proven that age is a factor in air carrier accidents, the agency said there are now only 40 pilots aged 60 or over employed by the carriers. This number, it says, could be expected to grow to 250 by 1967, with airline seniority standings placing a growing number of jet operations in the hands of the older pilots.

FAA believes that because of the medical facts already known which indicate a pattern of decreasing mental and physical ability with age, permitting pilots over 60 to remain in command of an aircraft carrying up to 165 persons at speeds of 550 mph. would be a hazard to air safety.

Operation of new jet aircraft by older, more senior pilots has boosted the average ages of jet pilots to a point considerably higher than that for the over-all airline pilot groups. High speed performance of the aircraft, coupled with their greater passenger capacity, the agency says, makes jet operations more critical and places a greater responsibility on the pilot.

Based on its present knowledge, FAA made the following statements to support the 60-year retirement age:

- **Increasing frequency** of possibility of heart attacks and strokes after the age of 40 indicates that 24 of every 1,000 pilots over the age of 55 can be expected to suffer this each year.
- **Pilots aged 55** or over required twice as long to qualify on the Boeing 707 jet transports as compared with those under 40 despite their greater experience. Those under 40 averaged about 16 hr., while pilots 55 to 59 averaged 25 hr., with some requiring as many as 40 hr.
- **Foreign air carriers** already have established compulsory retirement ages as well as age limits for jet transition. British Overseas Airways Corp., KLM Royal Dutch Airlines and Iberia require retirement at 55. SAS requires a 60-year retirement. Sabena, which has only 11 pilots over 45, is considering a retirement age. Age limit for jet transition is 53 for BOAC, 46 for KLM, 47 for Sabena and 53 for SAS.
- **Aircraft manufacturers** and industries other than airlines have no pilots over 60 and only two over 54 while a sample of 26 of the largest non-aviation business organizations which now employ pilots shows that only two are over 54, and companies which build commercial airliners report that their oldest active pilot is 49. While the new regulations for air carrier training programs and copilot qualifications "may result in additional costs" to the airlines, FAA noted that the extra expenses are "far outweighed" by the considerations of safety involved. The regulation is considered necessary, FAA said, because, although airlines previously had full control over their training programs subject to FAA inspection and many had excellent courses, others failed to achieve the minimum safety objectives sought by the training requirements of the Civil Air Regulations. Airlines will now be required to submit such programs for FAA approval and must seek approval of any subsequent changes.



PLACEMENT of de Havilland DH-121 turbojet engine pods forward of tail section is shown on this shape in a wind tunnel.

Area Rule Cuts DH-121 Drag Coefficient

By John Tunstall

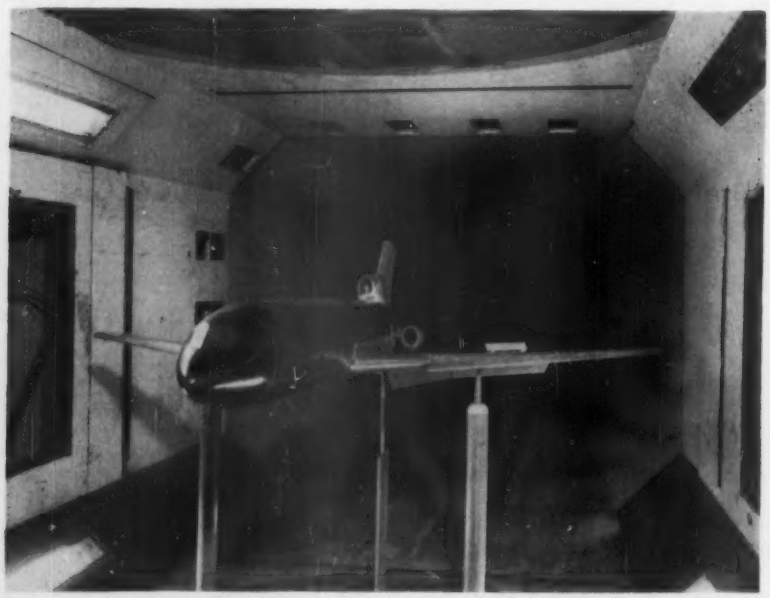
London—Use of the area rule concept on the rear fuselage of the de Havilland 121 jet transport in wind tunnel tests at Hatfield has dropped the drag coefficient 0.02 in the upper speed ranges, designers told AVIATION WEEK.

Engine pods, although aft of the pressurized cabin structure for safety and noise reasons, have been placed as far forward of the fin as possible to achieve a smooth area distribution along the whole length of the fuselage (AW Aug. 31, p. 40).

A further contribution is derived by shaping the top and bottom profiles of the side pods which are not symmetrical.

Acquisition of its own low speed and transonic wind tunnels at Hatfield has enabled the company to carry out an extensive model test program while the basic design progressed, which was not possible with the Comet jet transport. A switch to light alloy development models also speeded the test program and cut costs.

In the wing development program for the DH-121, many modified versions of eight different wing configurations were tested in both cruise and landing speed regimes. High speed tests were carried out on a number of rear fuselage sections.



MODEL complete with engine intakes, flaps and flight controls undergoes low speed handling tests with the hinged leading edge drooped in 9 ft. x 7 ft. wind tunnel.

Severe Handicap

Lack of these wind tunnel facilities proved a severe handicap in the original Comet design program when de Havilland had to depend solely on the much overloaded Royal Aircraft Establishment tunnels at Farnborough. This situation restricted tunnel tests to the basic design proposal, and no testing concurrent with the design program was possible. It was later changed to the wing leading edge being introduced without ground effect tunnel testing, which led to the takeoff stall condition associated with the first model of the aircraft.

Different inner wing configurations based on various combinations of root thickness, rates of change of wing root incidence, and root profiles superimposed on three basic wing designs led to eight semi-span models being tested. Basic wing sections were distinguished by position of the maximum thickness. As a result of this extensive program, de Havilland was able to raise the critical Mach number to 0.875 and reduced the drag coefficient by an increment of

0.01-0.015 over the cruising speed range.

The innerwing design adopted is regarded by de Havilland as being in line with basic Boeing and Douglas design philosophies and features a well-rounded leading edge to increase the critical Mach number, and a thickened root section. Actual details of this section have not been revealed, but the company claims to have resolved conflicting aerodynamic and structural problems with better than conventional solutions in each of these two categories.

The company says it has evolved an outstandingly simple wing root structure, easy to make and maintain and relatively free from areas that are fatigue-prone.

Leading Edge

The rounded leading edge, the subject of recent Boeing changes (AW Nov. 9, p. 42), has been part of de Havilland thinking since the design was conceived four years ago.

But the theory only goes one third of the way with this artifice, according to one of de Havilland's senior aerodynamists.

The optimum flaring of the nose profile spanwise was resolved only by extensive detailed tunnel research work and testing.

Tests on another feature of the DH-121—the hinged, drooped leading edge—confirmed an interaction between the nose radii and the droop characteristic and enabled the span of the droop to be reduced inboard.

With fixed hinges instead of cumbersome tracks, de Havilland claims that a drooped edge is easier to engineer and de-ice than slats, is more reliable because it is simpler and gives away nothing aerodynamically. De-icing is simpler because the arrangement is free of flexible hoses needed to de-ice slats.

Commenting on the use of light alloy models, de Havilland considers that besides being quicker and easier to make than steel models, they were much more easily modified. The metal proved fully adequate for development work, which in the opinion of workers at Hatfield pointed to over-conservatism in the use of steel in this field, at least in Britain.

Semi-span wing models were mounted from false side walls in the 2 ft. x 2 ft. high speed tunnel at Hatfield.

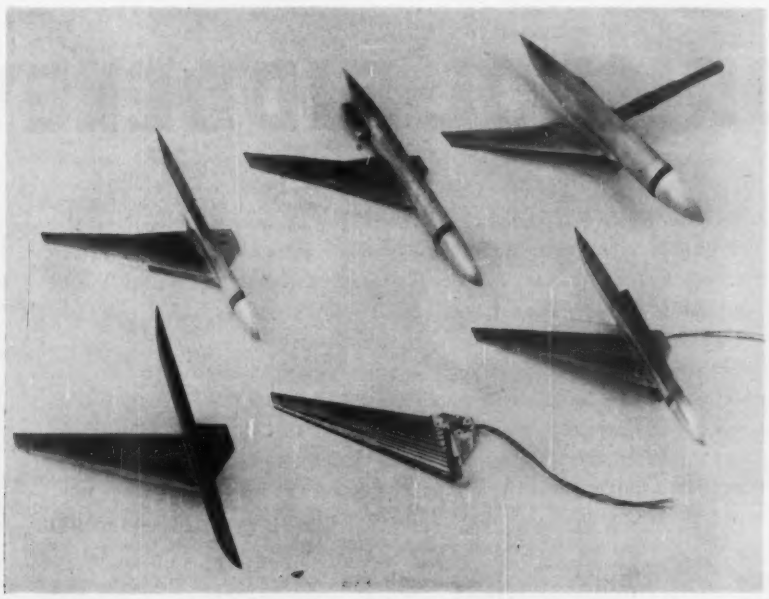
Oil-white oxide was used extensively in the investigation of shock wave systems.

Landing and takeoff characteristics were investigated in the 9 ft. x 7 ft. low speed tunnel using a larger complete model.

A flat plate under the model was used to simulate ground effects. The plate was slotted ahead of the aircraft to divert the boundary layer underneath the plate.

Satisfying Result

One of the most satisfying results of this phase of the test program at Hatfield is regarded by the company as being the fact that when a larger complete model was assembled and tested in the 8 ft. x 9 ft. transonic tunnel operated by the Aircraft Research Assn. at Bedford, no subsequent changes were required.



SELECTION from a family of eight light alloy half-wing models shows investigation of various thickened and non-thickened wing sections during DH-121 research.

Higher Jet Rates Asked by Insurer

London—At the end of the first year of business with jet aircraft operators, a London insurance firm last week gave some statistics to support its case for charging higher rates for jet airliners.

Experience with jets to date had been reasonably in accordance with what could be predicted from piston and turboprop experience, according to Alan Hunter, chief surveyor of British Aviation Insurance Co. in a speech to the Insurance Institute of London. Record of the best piston-engined aircraft showed that four out of every 100 such aircraft built were completely destroyed, in addition to important partial losses, Hunter said.

"Even if we do as well as this with jet aircraft, we are now dealing with values which would give us losses on the big American jets on the order of $20 million per 100 aircraft built," he said.

If these trends continue, by the time 500 jets are delivered, there may be only 480 remaining, he added.

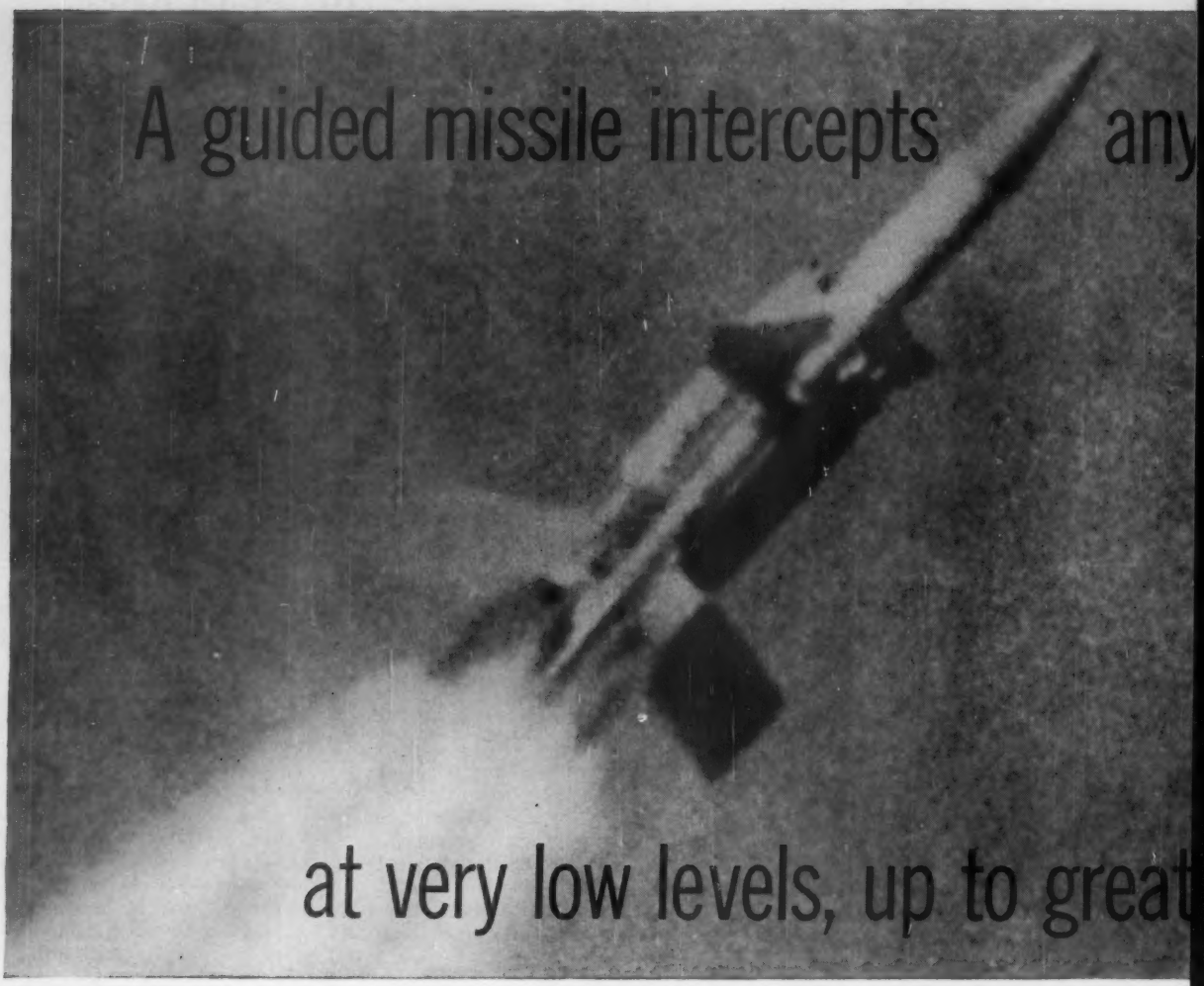
Hunter said there were currently about 600 jet and 800 turboprop airliners on order—nearly half the number of piston-engined transports now in use.

"We have a business in which values are going up and up and the spread of risk is going down and down," he said. Total hull values of world's aircraft would soon total $5.6 billion, he added.

Since each airline had an arbitrary calendar renewal date for its insurances, he said, and new aircraft premiums were based only on pro rata premiums from date of delivery to the next renewal, underwriters never earned what they needed. He cited this current first year of jet business where some 60 jets had been insured without insurance companies getting an annual premium on those aircraft.

Hunter suggested that a full 12 months' premium be paid for each aircraft from date of delivery.

Commenting specifically on the Boeing 707 and de Havilland Comet 4, Hunter said the fact that Boeing already has carried its millionth passenger and reached utilization figures of 10 hr. a day spoke well for efficient airline support and the aircraft itself. Although the Comet 4 had been involved in three major incidents and one had been totally destroyed in Paraguay, he noted "several encouraging features" about the accidents: aircraft had hit the ground at a forward speed of 140 kt. without damaging the integrity of the fuselage and strength of the aircraft together with very efficient anti-fire devices had saved a number of lives which "undoubtedly" would have been otherwise lost.



...AND BRISTOL SIDDELEY

Bristol Siddeley Engines Limited produce the Thor ramjet. Two Thors power the missile in the Bristol/Ferranti Bloodhound guided weapon system. This system forms the most effective defence against air attack at very low, up to very high altitudes. And the great flexibility and development potential of the ramjet ensure that Bloodhound will be able to intercept any attacking aircraft for many years to come.

The ramjet is the simplest air-breathing engine that has ever been devised and the Thor is virtually a stainless steel tube which can be lifted by two men. A thrust of over 20,000 lb at Mach 3 can be expected from a typical ramjet of the Thor's size.

At speeds of Mach 2.5 and upwards, the ramjet has a lower specific fuel consumption and a lighter weight than any other prime mover, and the higher the speed the greater its efficiency. In fact, it is the most efficient powerplant for long-range flight at high supersonic speeds within the earth's atmosphere.

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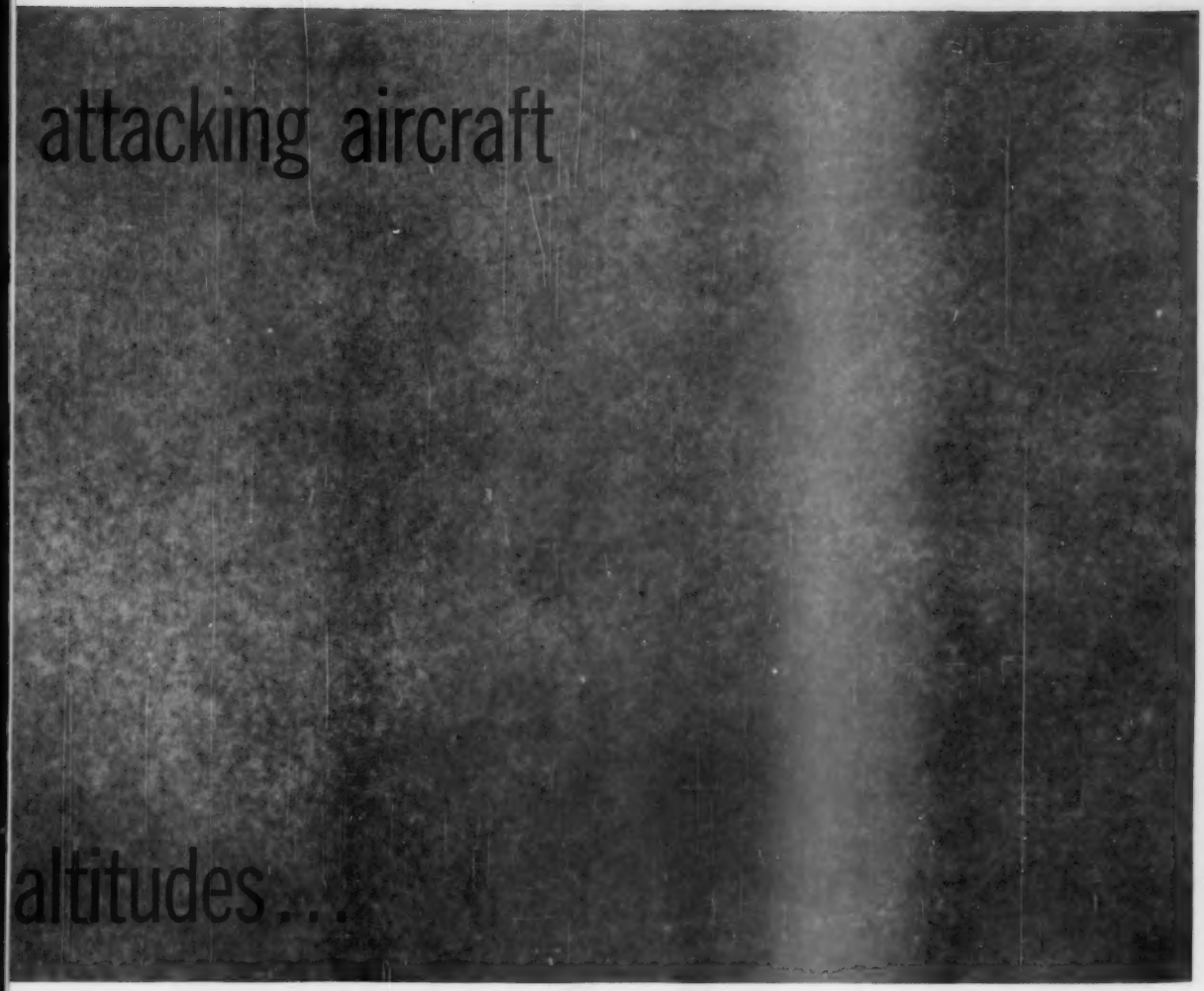
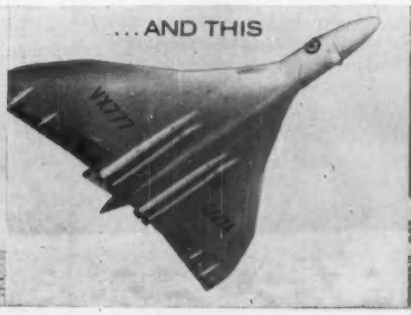


SUPPLY THE POWER

The Bristol Siddeley Marine Proteus powers the world's fastest naval vessels, the "Brave" class Royal Navy patrol boats built by Vosper Ltd. Three Proteus deliver a total of 10,500 hp—give these 96-ft boats a speed of over 50 knots. The Marine Proteus is quick-starting, flexible, reliable and holds large reserves of power for acceleration.



The Bristol Siddeley Olympus high-thrust turbojet powers the Avro Vulcan V-bomber—gives this delta-winged deterrent carrier a performance unsurpassed by any aircraft in its class. Current Olympus versions deliver 17,000-lb thrust dry—24,000 lb with reheat. Even more advanced Olympus versions are rated at 33,000 lb with reheat.

Bristol Siddeley Maybach diesels designed for a wide variety of applications, range from 200—3,000 hp. Here is a British Railways diesel hydraulic locomotive powered by two Type MD 650 engines, developing a total of 2,200 hp. A large number of Maybach diesel engines have been ordered by British Railways alone.

AIRLINE OBSERVER

► Five Latin American airlines are expected to announce a merger next month that would create a single international air transport system capitalized at $35 million. Initial meeting to discuss the plan was held in Panama last month. Second meeting, when technical aspects of the proposed merger will be discussed, will be held within two weeks in Lima, and a third and conclusive meeting will be held in mid-January. High costs of purchasing, operating and maintaining jet equipment were given as the reasons behind the action. The five carriers involved are Avianca of Colombia, LAN of Chile, Compania Ecuatoriana de Aviacion, Compania AREA of Ecuador and Faucett of Peru. Merged company would initially operate with five turbojet transports.

► Presidents of nine International Air Transport Assn. airlines operating between South America and Europe agreed at a special meeting in Paris to end their rate war in which IATA fares were being slashed by as much as 50% (AW Nov. 23, p. 47). Although it was expected the meeting would agree to a new common South Atlantic fare below the present level, the nine presidents agreed to maintain the present fare structure. Decision was reached at midnight of the first day of the two-day session.

► First carrier to announce rate cuts after Apr. 1 when an open-rate situation on most international routes probably will exist is South African Airways. The carrier plans to undercut the current lowest rates by 20% beginning next October when it introduces Boeing 707 turbojet transports on its routes. The airline was one of the supporters of British Overseas Airways Corp. at the International Air Transport Assn. traffic conference at Honolulu where the open rate situation developed as a result of BOAC's fight for a 20% cut below current tourist fares on Far Eastern and African routes (AW Oct. 19, p. 38).

► Airlines will launch an industrywide program designed to expedite the exchange and disposal of excess spares and parts. Total value of such parts now on shelves is estimated at more than $50 million.

► Lockheed Aircraft Corp. has received a purchase-for-lease order from Trans-American Aviation Corp. of Miami, Fla., for two Electra turboprop transports. The Trans-American Electras will be available for lease to any air carrier or to large companies that might require turbine-powered executive transportation.

► Aeroflot plans to continue the expansion of turbojet and turboprop service to new routes this winter. Tu-104B turbojets will be placed in service from Moscow and Leningrad to Simferopol in the Crimea. Il-18 turboprop transports will begin operating from Moscow to Yakutsk, Sverdlovsk, Ashkhabad and Murmansk and from Tashkent to Mineralnye Vody in the Caucasus. An-10 turboprops will be put on the Irkutsk-Yakutsk, Novosibirsk-Alma-Ata and Khabarovsk-Magadan routes in Siberia.

► Civil Aeronautics Board last week drew charges of "bureaucratic ineptness" by the Aviation Securities Committee of the Investment Bankers Assn. of America which wants the agency to be more mindful of the airline industry's profit needs in 1960. The committee conceded that the new blood in the Board resulting from the recent appointment of two new members may spark new interest in the industry's earnings problems. The committee also urged that Military Air Transport Service activities be confined to essential military missions only.

► Trans-Canada Air Lines and British Overseas Airways Corp. have signed an agreement calling for integration of transatlantic schedules and interchangeability of tickets. Ticket and sales offices of both companies will conduct business on behalf of each other.

► New Zealand National Airways Corp. has ordered four Fokker F-27 Friendship turboprop transports and taken an option on an additional seven. Leading competitor in the New Zealand sales campaign had been the Handley Page Dart Herald.

SHORTLINES

► **Air Transport Assn.** estimates that U. S. local service airlines will have carried 5,217,000 passengers by Dec. 31 as compared with 4.2 million persons in 1958. The association also estimates that the 13 local carriers will post gross revenues of $119,956,000 this year as opposed to $94,654,000 for 1958. Other categories in the ATA estimates are: passenger miles, 1,032,697,000 for 1959 as compared with 820.2 million last year; available seat miles, 2,310,212,000 this year versus 1,793.5 billion in 1958. By mid-1959, local service carriers were serving 540 cities over a 42,000 route mi. network.

► **Alitalia,** Italian state airline, will begin two Douglas DC-8 turbojet flights each week from Rome to Montreal beginning Apr. 1, 1960, in competition with Canadian Pacific Airlines' two weekly Bristol Britannia turboprop flights which are scheduled to begin on Mar. 1 over the same route.

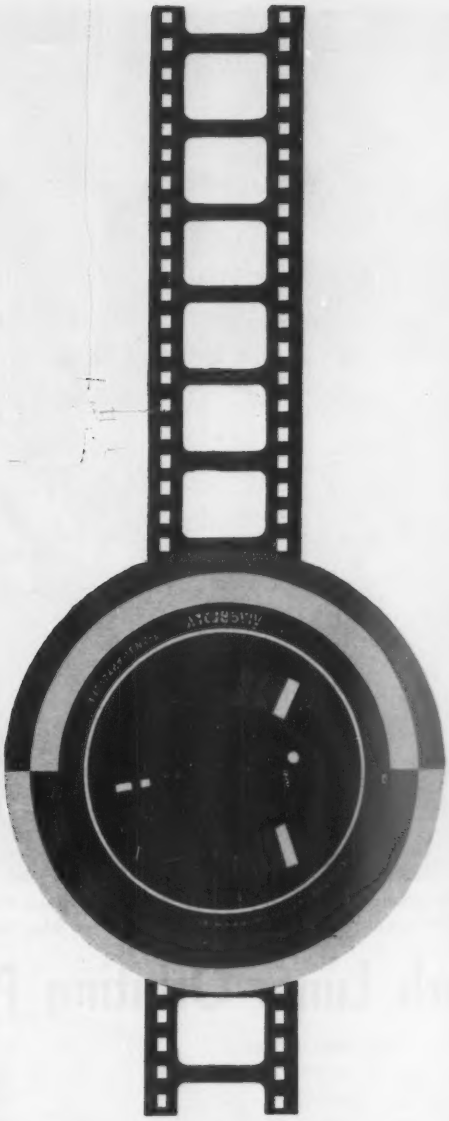
► **Allegheny Airlines** will issue a single ticket to groups of two or more passengers traveling together to the same city on its system under a new plan beginning this month.

► **Federal Aviation Agency** has asked for bids to be opened on Dec. 17 for the installation of six utility systems, four miles of taxiways and a jet parking apron 800 x 4,000 ft. at Dulles International Airport near Washington, D. C. Four landing pads for helicopters also will be constructed.

► **Irish Air Lines** has resumed flights on its European routes following settlement of the eight-day oil workers' strike in Ireland. Transatlantic flights were not affected by the walkout with service being maintained by a refueling stop at Keflavik, Iceland, during the strike. Planes en route from New York were fully loaded with fuel at Keflavik, flown to Dublin, turned around and flown back to Keflavik without refueling at Dublin, refueled in Iceland again and flown on to New York.

► **Pan American World Airways** is scheduled to begin weekly Boeing 707-320 service from the West Coast to Sydney, Australia, via Honolulu and Fiji, on Dec. 15.

► **Swissair** plans to begin three flights per week from Switzerland to Lydda, Israel on July 1, flying Sud Aviation Caravelle turbojet transports in competition with Alitalia, which is scheduled to begin its Caravelle service on a three flights per week basis in April.



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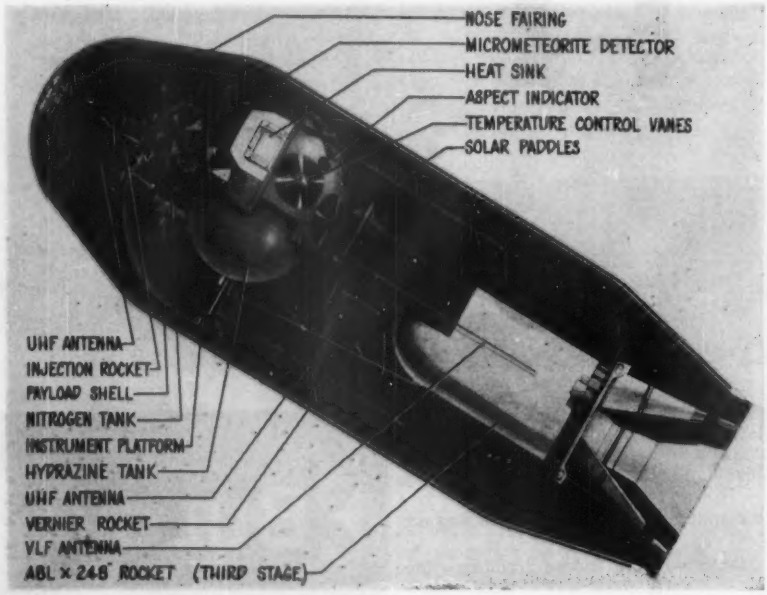
BULOVA

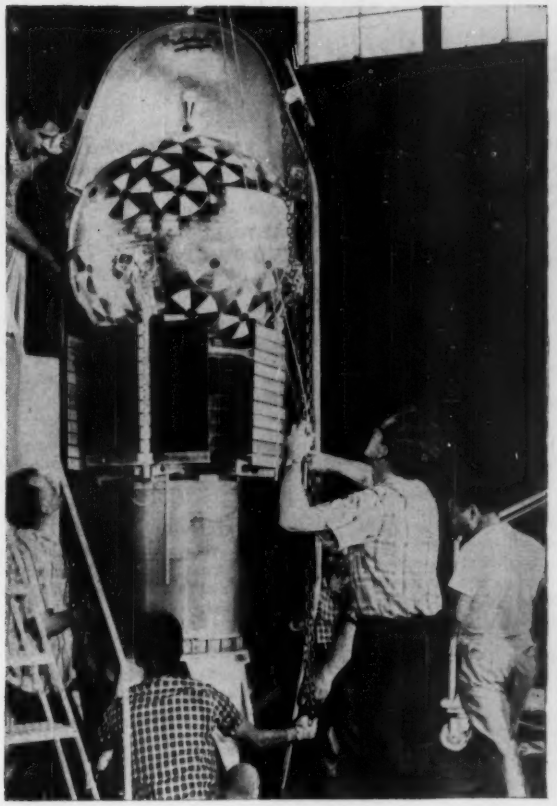
Payload that was to have been put into orbit around the moon is prepared at Cape Canaveral, Fla. Nozzle at top is a retrorocket that was to help control injection angle to ensure low circular orbit. Rocket had capability of firing twice.

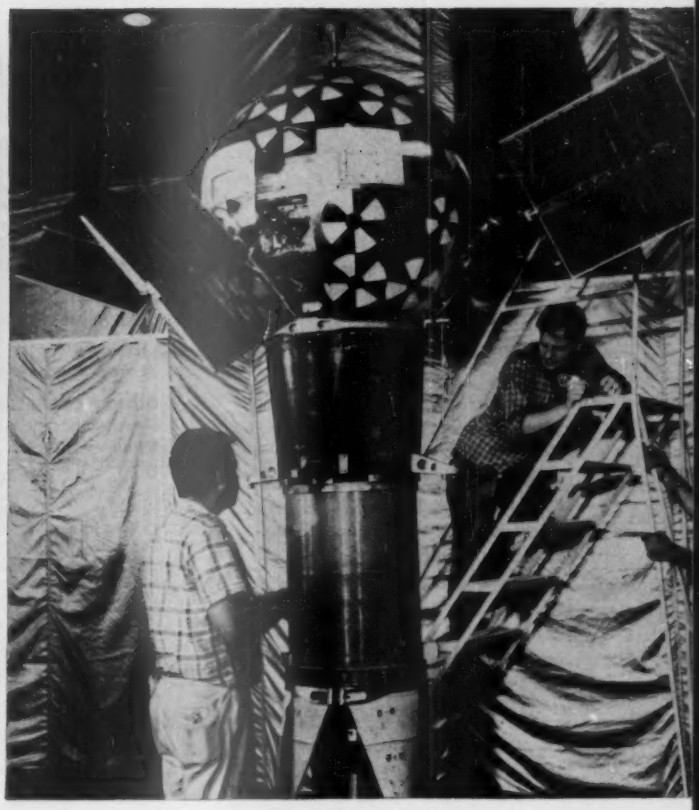
Attempt to Launch Lunar-Orbiting Payload Fails



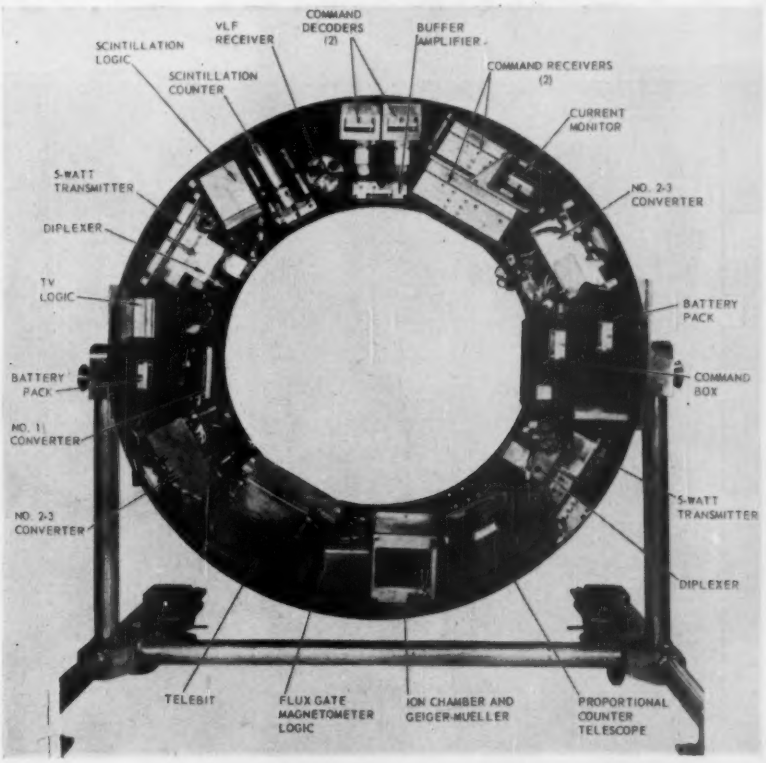
Artist's conception shows layout of payload when covered by plastic shrouding. Solar paddles are folded. UHF antennas bracket the injection angle rocket at top.

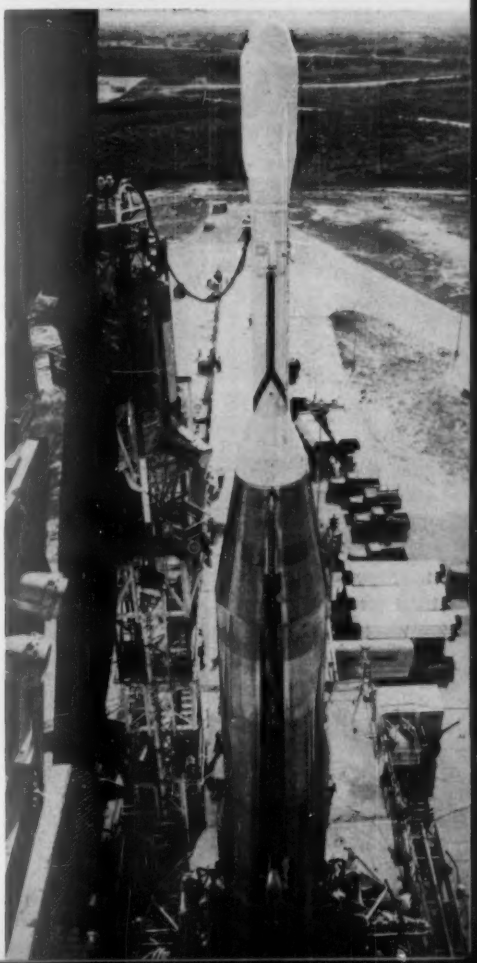
Attempt to send a complex 372-lb. payload into a low circular orbit around the moon failed due to malfunctions during the launch phase. About 130 lb. of instruments were to have scanned the lunar surface with a television-like system, measured propagation of very low frequency electromagnetic waves in ionized gas in a magnetic field, measured the moon's mass and the degrees of flatness of its polar areas; measured distribution and speed of micrometeorites encountered on the flight, and measured density and types of radiations in space. Backup payload existed but no backup for the Atlas-Able IV launching vehicle had been allowed for. Atlas 20-D, used for the firing, already had been borrowed from Project Mercury. Sophisticated payload had been aimed at demonstrating considerable scientific exploration capability in spite of the weight limitation imposed by U.S. boosters. Midcourse propulsion system with capability of being fired four times, and injection rocket, which could be fired twice, would have been first tests of ability to maneuver satellites. Atlas-Able was nearly 100 ft. long and weighed more than 260,000 lb. at launch.





Propeller-like devices on 372-lb. payload (above) were to control internal temperature during 2.6-day flight (AW Sept. 7, p. 29). Paddles contained 8,800 solar cells for converting sunlight to electrical current for recharging chemical batteries. Avionics gear is detailed below; over-all view at right shows plastic shroud that covered payload during flight.





unusual capabilities and stability

64 channels in 60″

On these two pages eight fully transistorized Model 850-1500P Preamplifiers appear actual size—each measures approximately 2″ x 7″ x 14½″. In racks of eight, 64 preamplifiers take only 56″ of panel space, and a blower unit another 4″. Necessary power and chopper excitation is provided by a completely transistorized Model 858-500P Power Supply that mounts at the rear of each 8-preamplifier unit, so that no additional panel space is required.

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Input circuit guarded, floating, isolated from output, can be grounded. Input impedance 200,000 ohms min. (Preamplifier also available at extra cost with 4-step attenuator with gains of 10, 20, 50 and 100 and smooth gain control to reach any intermediate setting.)

BANDWIDTH
DC to 70 cps (−3 db).

RISE TIME
25 ms to 99.9% of steady state value.

OUTPUT CHARACTERISTICS
Floating, independent of input, can be grounded.
Capabilities: ±1 v across 300 ohms, DC to 70 cps
±1.5 v across 300 ohms, DC to 40 cps
Output impedance 100 ohms. Output is across 300 ohm internal load, shunted by internal 4 mfd capacitance. Part or all of this resistance and capacitance can be supplied externally, in any combination to suit your application.

LINEARITY
±0.1% of full scale output (2 volts)

GAIN
100 (10 mv input for 1 volt output). Preamplifier with gain of 1000 (1 mv input for 1 volt output) also available on special order. Gain stability ±0.1% for min. of 24 hours.

INPHASE REJECTION RATIO
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INPHASE TOLERANCE
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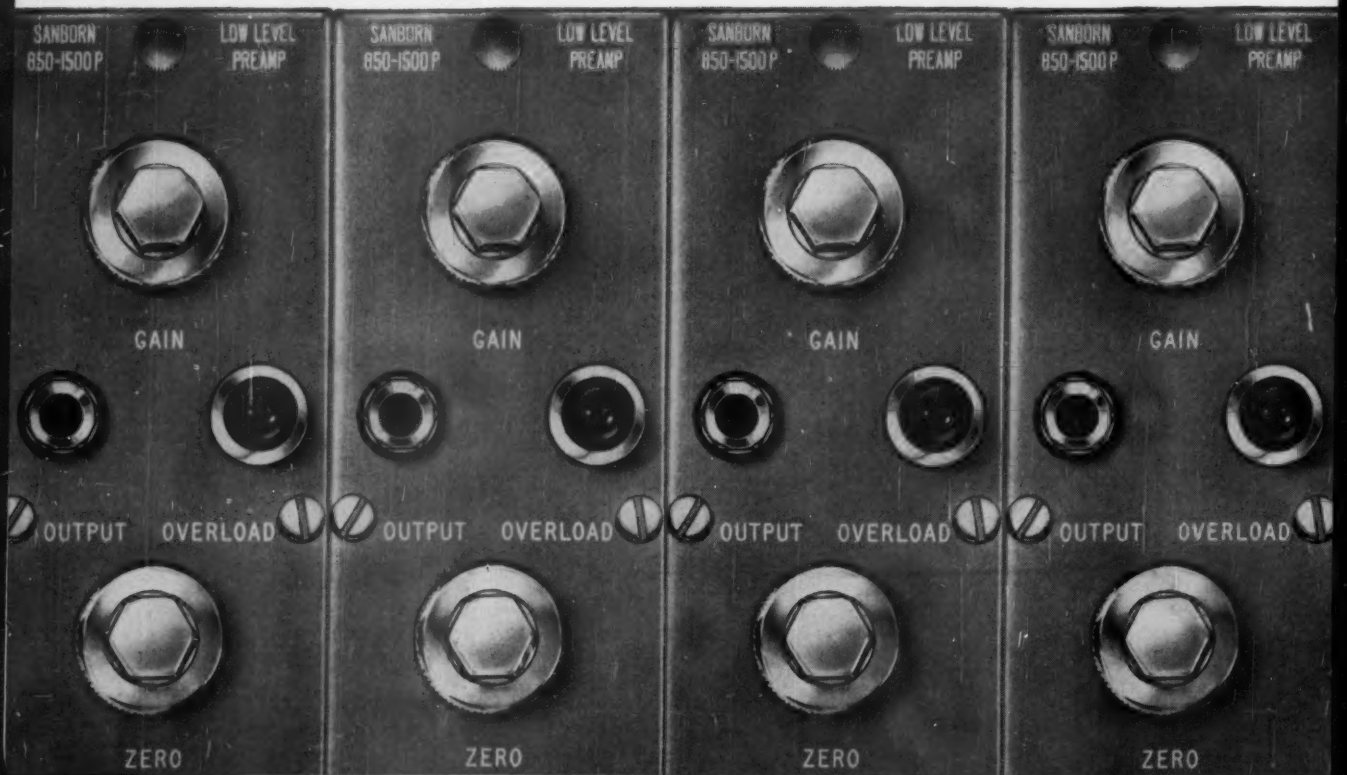
2 uv peak-to-peak referred to input (measured over DC to 100 cps). Noise plus ripple for full scale signal not to exceed ±0.1% of signal (measured wide band-ripple is 880 cps).

DRIFT
±2 uv referred to input, at constant ambient temperature, after 30 minutes' warm-up. Input drift temperature coefficient ±0.2 uv/°C, max.

OVERLOAD RECOVERY
Preamplifier recovers from fully blocked condition within 20 milliseconds after removal of signal. 10 volts of signal at input will not damage preamplifier.

POWER REQUIREMENTS
Each Preamplifier requires 2.5 watts; Model 858-500P Power Supply handles up to eight Preamplifiers.

New Data Preamplifier model 850



$462.50
per channel, complete

Each Model 850-1500P Preamplifier costs $400, each Power Supply for every eight Preamplifiers, $500. Consider the substantial savings over equipment with comparable specifications – when economy "per channel" is multiplied by the number of channels you're using. (All prices are F. O. B. Waltham, Mass., within continental U. S. A.)

What distinguishes this data preamplifier from others is *not* its specifications *alone*—but the *combination of this performance with high reliability, practical cost* and *small size.* Together, they make the Sanborn Model 850-1500P the logical choice for data processing systems in which tens or hundreds of channels of information must be handled.

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Minuteman Tests Yield Silo Design Data

Edwards AFB, Calif.—Series of underground silo test firings of the full-scale model solid-propellant Minuteman ICBM now being pushed here is uncovering critical environmental launching phenomena which promises to lay the groundwork for advanced follow-up testing at Patrick AFB, Fla., and Vandenberg AFB, Calif.

Underground silos at Edwards are preliminary test installations—two holes about 83 ft. deep and 26 ft. in diameter over-all (AW Aug. 3, p. 93). First group of firings in the series of tests at Edwards is being conducted with a "battleship" configuration composed of dummy second and third stages coupled to a live first stage which is partially loaded to give a limited burning time. Second group of firings in the series at Edwards will use lightweight flight cases more closely approximating the real configuration of the missile to give results that will closely approach operational conditions.

The full gamut of Edwards tests should provide enough environmental grist for architect and engineering services to design full-scale research and development installations for advanced Minuteman testing with a configuration very close in all respects to the projected operational missile. It is likely that Patrick will be chosen as the site for these facilities because of all the advantages the base itself offers as a test area as well as the wide expanse of the Atlantic Ocean for actual test firings.

Indications are that Patrick is preparing for these tests since two caissons are being sunk there now resembling the type of hole that Minuteman will require.

Firing Control

A launch control center for these Minuteman silo facilities would not be required since Patrick already has control blockhouses for its continuing ballistic missile test program. Minuteman control could easily be tied into these existing facilities.

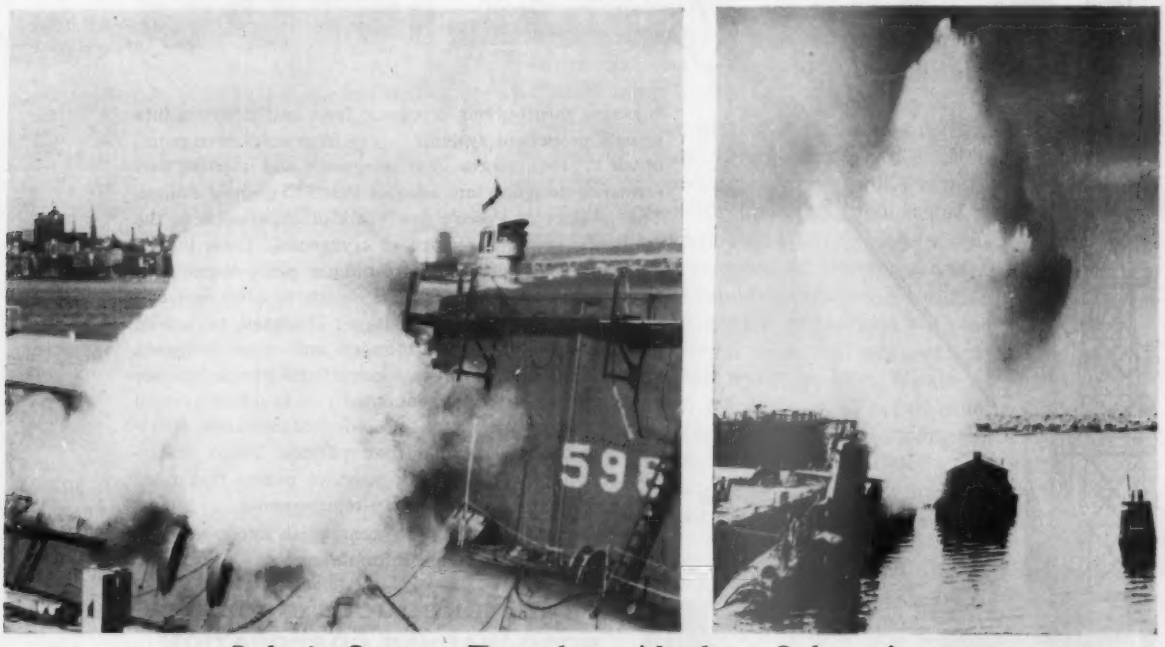
Considering the present state of the Minuteman development program and the number of basic problems that must still be solved before advanced research and development testing is funneled into the program, tests at the Patrick complex could be at least a year away.

After the research and development testing at Patrick, an operational development phase for Minuteman probably will follow. Since Minuteman will be a Strategic Air Command weapon, this operational development phase almost certainly would be conducted at Vandenberg AFB, the site of SAC's ballistic missile training and operational development program.

If the operational development phase is conducted at Vandenberg, chances are that it will not be with a complete system with components that have not been evaluated previously. This means that support equipment for the missile would have been proved out elsewhere, and the complete system assembled for checkout at Vandenberg as a logical operational proving site.

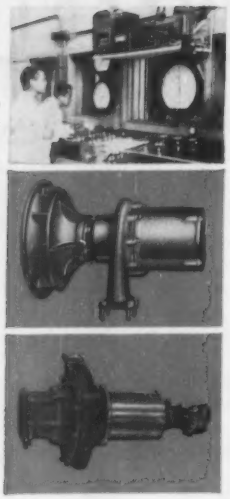
Meanwhile, in the Edwards silo launch development program for Minuteman, both silos are being used to ensure that the timetable of firings will stay on schedule and, should one of the silos be put out of commission, another will be available as a backup facility.

The first three shots in the initial series at Edwards AFB already have been fired successfully. Present schedule anticipates that the series of tests

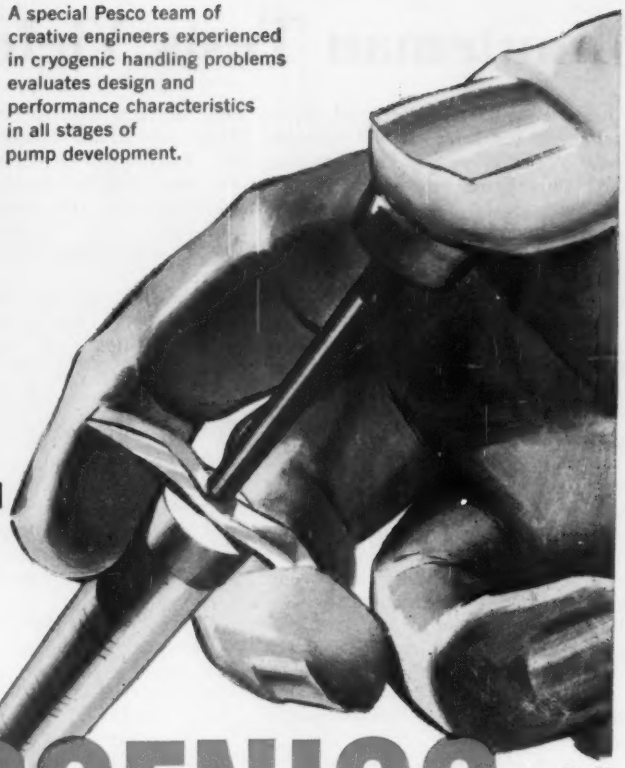


Polaris System Tested on Nuclear Submarine

Mushroom-like tower of water explodes from one of 16 Polaris missile tubes on nuclear submarine George Washington during firing system tests at Groton, Conn. Shape used was a one-ton cylinder, visible at top of spout at right. Unit was retrieved for later tests.



A special Pesco team of creative engineers experienced in cryogenic handling problems evaluates design and performance characteristics in all stages of pump development.



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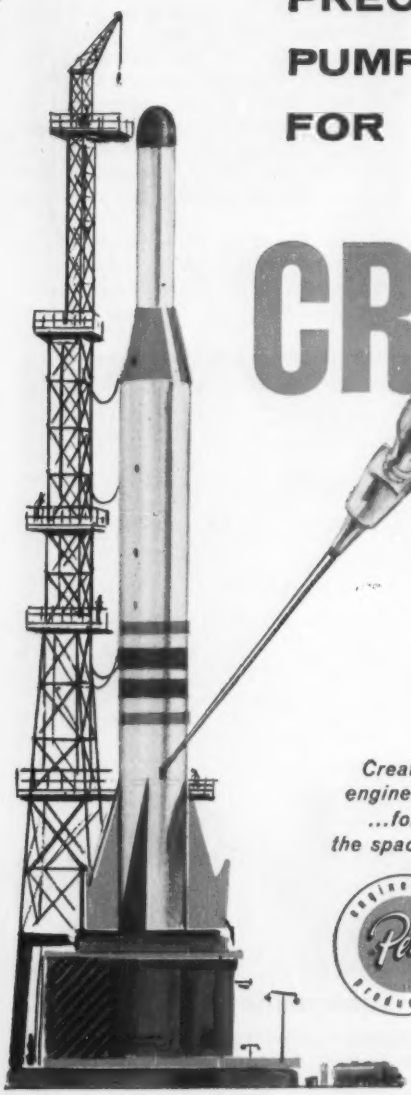
PRECISION PUMPS FOR CRYOGENICS



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at Edwards will run until April or May, 1960.

One of the major problems facing Air Research and Development Command's Ballistic Missile Division, which has cognizance of the Minuteman program, was determination of the least expensive, but highly efficient, configuration of the silo launcher. Economy of the silo design is a critical factor in the deployment of the Minuteman weapon system because of the large number of silos which probably will be used to ensure a reasonable factor of survivability for retaliation after any surprise attack. No specifics on the number of silo installation planned for the Minuteman system have been released, but the general estimate now under consideration for Minuteman's numerical strength ranges from the middle hundreds to the high thousands.

Silo Types

Three general types of silo schemes for Minuteman have been under consideration:

• **U-Tube.** In this scheme, the missile would be deployed in one of the arms of the U, with the exhaust directed around the bend of the U and up through the other arm to the surface.

• **Concentric liner.** This proposal uses a central hole with an annular exhaust space surrounding it to lead the gases to the surface. In effect, it is similar to the U-tube except that the exhaust gas passage is annular instead of down and up through the second U-tube arm.

• **Simple silo.** This is a single blind hole, with exhaust gases evacuating from the hole directly up the side of the missile. This scheme would use a flame deflector—a configuration similar to the center portion of a simple household orange juice squeezer. Flame deflector also would be used with the concentric liner solo configuration.

Except for the U-tube type of silo, no previous data was available on silo environmental phenomena.

Simple Silo

The simple silo was the most difficult configuration technically but indicated the greatest promise in economy and uncomplicated operation. It was decided to tackle this silo scheme first and, if it did not prove feasible, resort to the U-tube or concentric liner approach as an alternate.

Thus far, tests in the Edwards silos have indicated no reason to doubt the feasibility of the simple silo scheme, or even to consider a backup effort with either a U-tube or concentric liner silo.

In the full-scale model firing from the Edwards silo, the missile is tethered at the nose by a nylon cable, which takes the form of a yoke to restrain the missile so that it will not reach more than a few hundred feet above ground

U. S. Air Force Academy mascot "Mach I" inspects nose dome—part of Texas Instruments infrared optics that lead falcon missile to impact.

INFRARED SPECS FOR THE FALCON

Falcon Missile— as deadly as its feathered namesake — is guided to the kill by Texas Instruments infrared optics. Unlike nature's Falcon, this Air Force missile has only the combative instinct, attack accuracy, and destructive impact that are built into it at the design and manufacturing levels.

Imparting these instincts to inanimate systems is the business of TI optics engineers and craftsmen. Leading designers and producers of silicon, germanium, quartz, and other optics for infrared applications, the TI optics team has fingertip familiarity with unusual materials suited to specific portions of the spectrum. In one of the nation's best equipped facilities, TI optics specialists grind, polish and coat components with accuracy that exacts the most from even the weakest infrared signal. This experience can work for you. Whatever your needs ... prisms, lenses, windows ... TI's full-time engineering service, modern computers, and complete optics facility can meet your requirements from design to delivery. For detailed information on any phase of precision optics technology, contact SERVICE ENGINEERING.

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Surface type thermostat. For surface "area contact" temperature sensing. Employs the latest in high heat resistant materials for adequate ambient temperature isolation and excellent shock and vibration characteristics. (Used by Northrop Corporation for controlling critical mass temperature in a sub-miniature accelerometer.)

2 INCHES LONG

Well type thermostat. Cylindrical shape —suitable for "blind" well applications for sensing case temperatures. (This type thermostat being used by Sperry Gyroscope Company to sense and control accelerometer housing temperature.)

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Thermostats tested at 100G shock; vibration 10G's to 2,000 cycles per second without malfunction. Tests have been run a total of over 2 million cycles, and calibration remained within $\frac{1}{10}$ of 1° of original setting.

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Provides all the information necessary to determine the right thermostat for the job. You order out of the bulletin; VĀP-AIR ships without delay.

Bring us your temperature control systems problems. There is a wide variety of other VĀP-AIR electronic controls, valves and actuators, both mechanical and electro-pneumatic, to meet your requirements over a wide range of response time.

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level upon firing of the partially loaded first stage.

Partially loaded first stage incorporates a thin core of live propellant inside a full-size case. The balance of the material between the core and the case is inert. The propellant burns its full length simultaneously, and the thickness of the burning core provides sufficient grain to propel the full scale model out of the hole and then give it some altitude.

Basic question originally arose with regard to establishing the silo diameter to accommodate burning phenomena and the missile diameter, which is fixed.

It would be advantageous to use as small a diameter as possible for the operational silo because excavation costs would be less, weight and cost of an operational silo door would be less, and the silo itself would be easier to harden.

Previous studies indicated that the silo diameter limit should be between 12 and 16 ft. for the full-scale missile. But, in effect, this actually was an unknown range, which the Edwards tests attempted to resolve.

The actual holes prepared for the Edwards silos are considerably larger (26 ft. in diameter) in order to provide access by elevator and stairs to the silo caisson, also to allow removal of the caisson for replacement with another to give a silo of a different diameter.

Silo hole was made about 83 ft. deep to provide a suitable distance between the missile exhaust nozzle and the flame deflector at the bottom of the silo. This distance was a critical dimension in that it was one of the unknowns which had to be evaluated. To provide an easy method of varying this distance, it was decided to have ready an additional section of silo caisson to fit on top of the silo hole proper so that the additional section would protrude above the top of the silo to provide the extra silo depth.

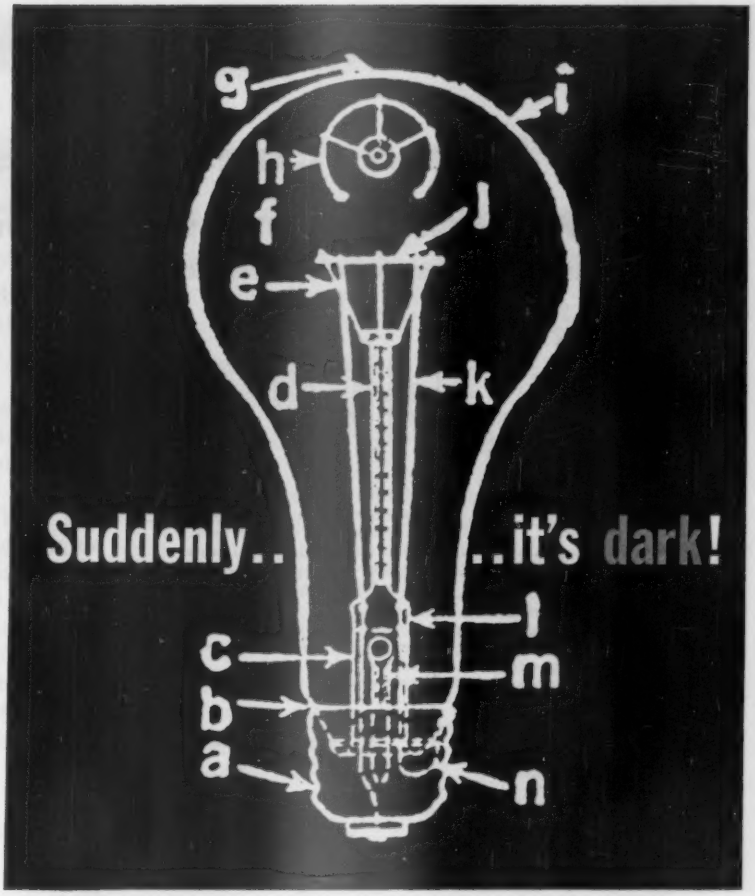
In trials to date, it has not been necessary to use this additional section, tests indicating that the nozzle-to-silo bottom distance as originally estimated has been sufficient.

First full-scale model firing from an Edwards silo utilized a 16-ft. caisson diameter.

Results of this test were so favorable that the switch immediately was made to a 12-ft. diameter configuration for the successive firings and the next two firings—second and third in the series—with the 12-ft. diameter opening have been entirely successful.

Essentially the same data is obtained in the successive firings, but readings are taken at different locations along the missile and silo sides, also using different instrument frequency responses and sensitivities.

Already obtained are a full set of



A pretty dark situation, indeed—when a *single* electron tube failure can shut down an equipment or entire production line test facility! Use IERC's new set of a, b, c's to help you get improved electronic equipment reliability. **a.** The practice of replacing tube failures in manner and attitude like that of replacing a light bulb is neither protection nor cure against a continuing high rate of electron tube failures! **b.** Downtime, labor replacement costs often add up to 10 times the tube cost! **c.** You can actually increase tube life up to 12 times by specifying and using IERC Heat-dissipating Electron Tube Shields! The full facts, in the form of **d.** complete product literature, **e.** test reports, **f.** engineering data and **g.** tube shield application guides, especially prepared to help you "see the light," are available on request—write today!

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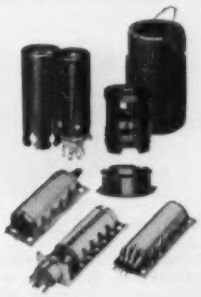

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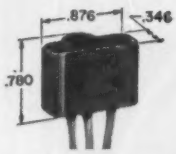
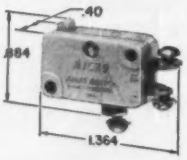
Series "54PB" alternate-action pushbutton—Lighted pushbutton saves panel-space, provides visual indication. Two-level position of button offers additional indication. Each operation transfers circuit of the maintained contacts.



Series "SE" small, sealed switch—Smallest environment-free switch. Potted leads. Leaf and roller-leaf auxiliary actuators available.

Series "HS" hermetically sealed switch—All seals in accordance with Par. 5.2.2, MIL-E-5272A. Insures constant operating characteristics in all atmospheric conditions.



Series "V3" high temperature basic switch—Synthetic mica case withstands radiation, 600°F temperatures. 30 vdc rating: ind. 10 a, res. 10 a, motor 6 a.

Each of the switches illustrated on these pages represents a different series of MICRO SWITCH precision Switches . . . Each switch has been designed to high reliability standards for a particular purpose . . . Each series includes many variations—sizes, weights, contact arrangements, electrical characteristics, housings, actuators, sealing, temperature, shock and mechanical characteristics . . . For example, there are 100 different switches in the "EN" Series . . . No other source of precision switches offers as broad a line . . . Furthermore, no other can offer the services of as large a staff of Application Engineers—in branch offices at strategic points throughout the country. Consult the yellow pages.

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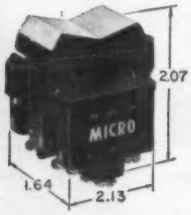
Series "ET" electrically released toggle switch—Works as a momentary action switch, but is converted to maintained contact when built-in solenoid is energized. Permits remote electrical release. Environment and immersion-proof enclosure. Available in 1 or 2-pole design.

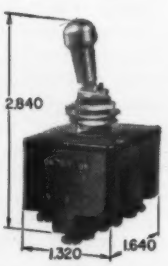
Series "EN" impact-resistant switch—Compact, environment-proof, corrosion-resistant switch. Has miniature plug-in receptacle. Two spdt switching units.



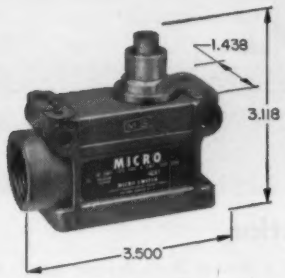
Series "TP" rocker-actuated key switch—Provides position and edge-light indication. Rugged, sealed case with stepped terminal design. Available with 1, 2 or 4-pole circuitry.

Series "TL" toggle switch—Rating at 28 vdc: res. 20 a, lamp 7 a, ind. 15 a. Available with variety of toggle lever positions. Provided in 1, 2, and 4-pole design.

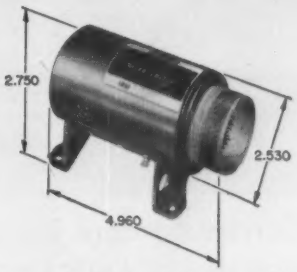
Series "TL" pull-to-unlock toggle—Rugged, sealed 4-pole toggle switch has integral pull-to-unlock lever. Available in a variety of locking arrangements. Also in 1 or 2-pole designs.



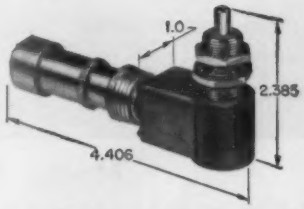
available range of precision switches marine and ordnance applications



Series "CE" G.S.E. limit switch—Weather-proof, corrosion-resistant indicator and limit switch. Rugged push plunger actuator.

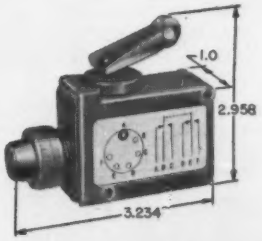


Series "1RS" high reliability telemetering switch—For missile program sequencing. 24 gold-contact switches and rotary solenoid in hermetically sealed container.



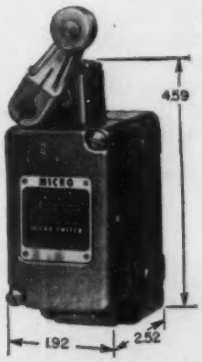
Series "EN" shock-resistant switch—Meets requirements of U.S.N. Bureau of Ordnance for shipboard launching equipment. Environment-proof construction.

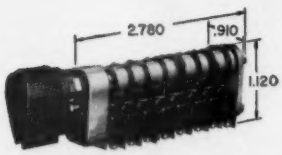
Series "EN" linkage-actuator switch—Rotary actuator adjustable through 360°. 4-circuit basic switch. Rating 10 a, 115/230 vac, 30 vdc. Environment-proof housing. Potted, sealed leads.



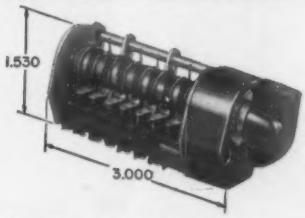
Series "EP" roller lever switch—Rugged, sealed two-hole side-mount enclosure. Two high-capacity spdt basic switches. Sealed connector receptacle.

Plug-In Limit switch—Series "200LS"—Heavy duty switch for indicator and limit functions in G.S.E. applications. Switch can be replaced in seconds. Available in variety of actuator designs.

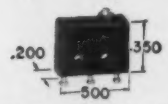




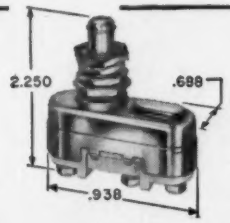
Series "17AS" rotary selector switch—Compact assembly handles eight separate circuits with infinite switching sequence. Available with fewer switch units.



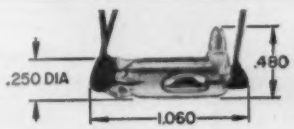
Series "28AS" cock-and-fire rotary—Positive, snap detent positions. Reliable operation, non-tease circuitry. Innumerable switching sequences. Available potted in steel housing.



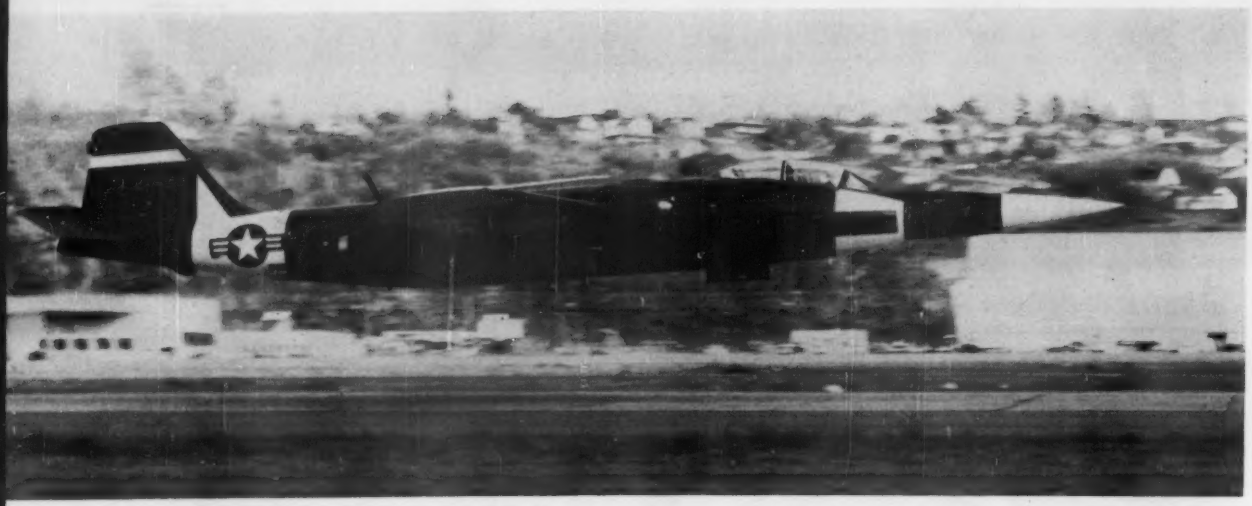
Series "1SX" sub-miniature switch—Smallest precision, snap-action switch. Big switch features: two generous-sized mounting holes, rugged easy-to-wire terminals, 5-amp capacity at 115/230 vac.



Series "HT" 1000°F switch—World's "hottest" precision switch. Operates reliably near afterburners, etc. Bushing mount. Also available with roller plunger and side mount, pin plunger.



Gyro mercury switch—Most sensitive tilt switch (0.15°). Low angle and low mass shift make it ideal control for vertical gyros, stable platforms, rockets. Reliable operation at—65°F.



Martin B-57 Carries Bomarc B Nose Section

Martin B-57 has been modified in forward section to carry the nose and part of the guidance section of a Bomarc B air defense missile for tests at Eglin AFB, Fla. Hybrid plane-missile will check out capacity of Eglin Gulf Test Range to handle flight tests of the 400-mi. range Bomarc B, particularly the capability of the range telemetering system and air-to-ground transmission from the missile package.

data on pressures, temperatures, acoustic environmental factors, vibration and silo durability.

Silo materials are not a consideration in this study to date.

However, results obtained in the test program will indicate materials that might be used for silo design criteria—both for the future test program and the ultimate operational configuration.

For the series of firings in the Edwards silos, Boeing Airplane Co., the assembly and test contractor, is conducting the tests under the Ballistic Missile Division's field office management.

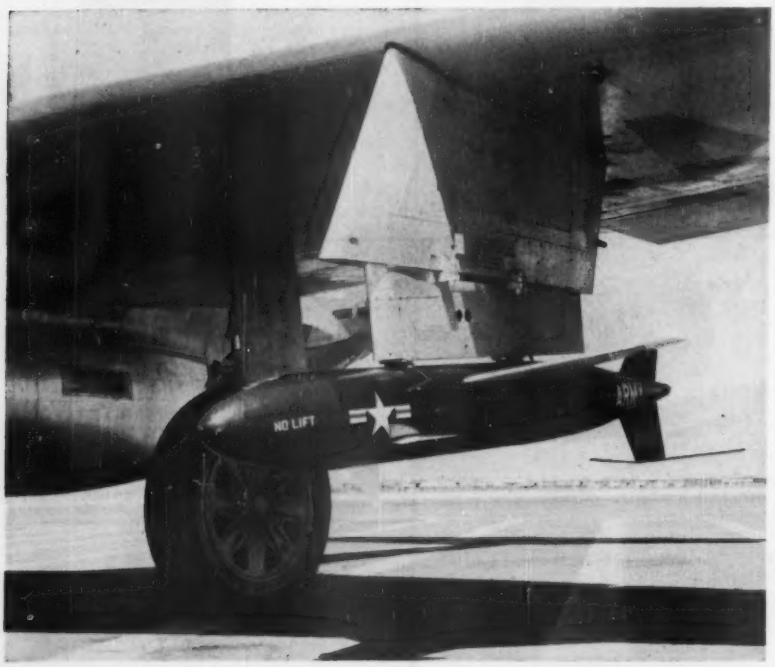
Air Force and Boeing technical personnel did not go directly to the full-scale model Minuteman tests. A number of preliminary investigations were conducted:

• **In first trials,** the Air Force Flight Test Center personnel at Edwards established a crude rig—essentially a steel tube—in April, 1958, to determine that the simple silo configuration would not be disastrous in a firing (AW Jan. 19, p. 58). A home-made missile test device was constructed which simulated realistic thrust-to-weight ratio for Minuteman, but no simulation of flame temperatures or chamber pressures was attempted. A number of successful test firings have been conducted with this rig.

• **Next step,** begun in December, 1958, was to establish a 1/20th scale cold flow rig—a simple arrangement of a silo and missile, with compressed gas introduced through a sting at the front end of the missile. With this simple silo static rig, essentially a wind-tunnel arrangement, about 2,200 runs were made, varying the test parameters such as silo configuration, silo diameter and cant angle. Data obtained included aerodynamic force and moments on the missile, which helped to determine missile stability. Also obtained was data on flame deflector phenomena.

• **Hot flow experiments** were conducted at Edwards AFB in September, 1958, by Air Force Flight Test Center personnel. Approximately 190 tests were made, using a modified 2.75-in. aircraft rocket. These tests produced qualitative information on promising flame deflector shapes, as well as data on localized heating on the Minuteman airframe.

• **More advanced supplementary** experiments were conducted in a 1/20th-



Radioplane RP-76 Rocket-Powered Target

Radioplane RP-76 solid rocket-powered target missile will be used in U. S. Army Nike Ajax and Hercules high altitude training missions. RP-76, being built by Radioplane under a $7.5-million contract, is radio-controlled and is recoverable by parachute. Airframe is mostly laminated glass fiber plastic. Target has reached Mach .94.

scale hot flow rig. These were conducted at Boeing's plant and utilized a small rocket engine in a static arrangement.

Approximately 150 runs were made with this rig, producing additional information on aerodynamic forces and moments.

Heat Data

Also obtained were heat transfer rate data (not attainable with a cold flow rig) and acoustic data.

• **Next experiment,** also using a simple silo configuration, employed a one-third scale static rig at Edwards AFB, with tests conducted by Air Force Flight Test Center personnel. First firing with this arrangement was in February, 1959. The silo was mounted horizontally for convenience of operation. Investigation continued through April, 1959, and, after four tests had been run, Boeing Minuteman assembly and test personnel took over the previous experiments which had been run by Air Force Flight Test Center staffers. To date, approximately 15 runs have been made with the one-third scale model static test rig.

Experimental Opportunities

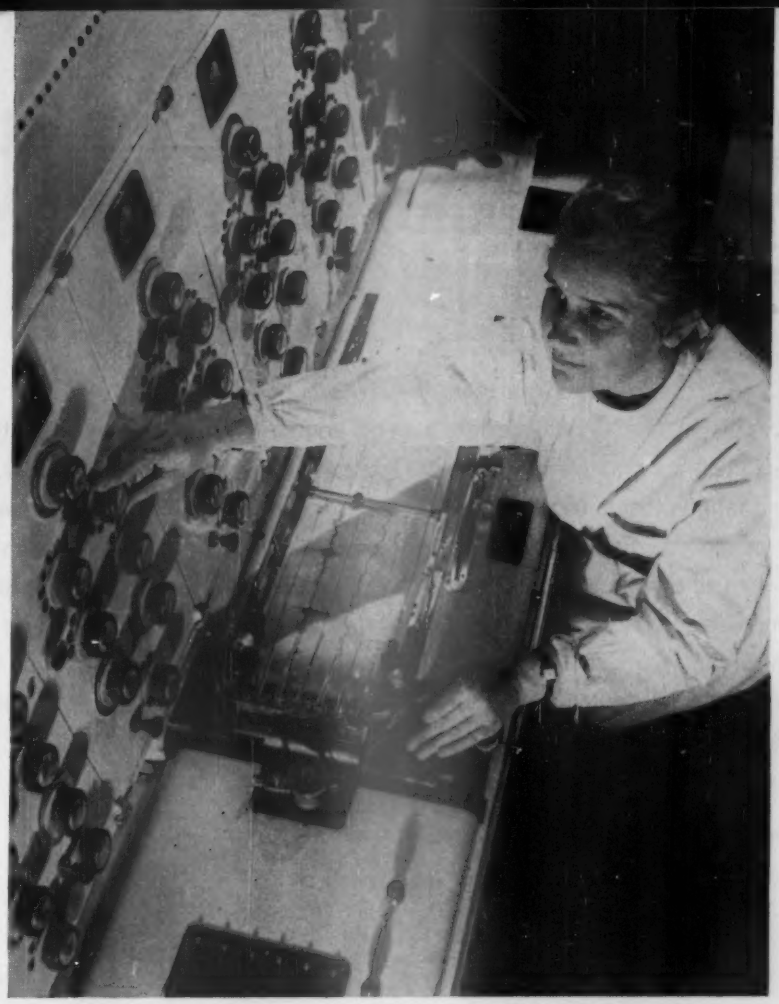
This rig actually provided the first experimental opportunity to:

• **Conduct experiments on a scale** sufficiently large to indicate the nature of the full-scale problems.

• **Confirm results** of the 1/20th scale tests as well as flame deflector phenomena.

• **Accumulate acoustical** data reasonably representative of Minuteman silo environment.

All these preliminary scale experiments established parameters of safety and ground rules for the full-scale silo tests at Edwards which followed.



Soviet Pilot in Altitude Chamber

Soviet high altitude test chamber to study physiological reactions of pilots for possible space use is in operation at Moscow. Above, Zoya Arapova, senior laboratory worker, checks control instruments; note chart to record reactions. Below, Gennady Mikhailov, a test pilot, is shown in the chamber wearing pressurized equipment, which includes chap-like fur on legs.

A single source for force simulative test facilities

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Avionic Makers Fight to Maintain Growth

New York—Rapid growth by many avionic companies has brought with it related problems, such as demands on management to keep the rise rising or the competitive drive to take profitless development contracts in the hope of gaining new production business.

A typical case in point is Laboratory for Electronics of Boston. This company almost went bankrupt because of three development programs on which more development was required than originally estimated: a trailer-borne radar system and SPAR, a precision approach radar system, which cost the company $1¼ million, and Diana, a large-size computer system.

In 1956, the company lost $544,000 and new management was brought in. In its 1959 fiscal year, ended Apr. 30, the company more than doubled its 1958 volume, reaching a total of $20,410 and it earned $578,000 after taxes. It was able to cut its accumulated deficit from $718,007 in 1958 to $140,081.

Most of the rapid rise in volume is due to the company's APN-105 and APN-130 doppler navigation systems for the Republic F-105 Thunderchief fighter bomber. Of the company's 1959 volume, a contract for 130 of these systems accounted for $13,800,000 and of the company's fiscal year end backlog of $36,200,000, two doppler production contracts accounted for $29,800,000.

LABORATORY FOR ELECTRONICS doppler navigation system in the Republic F-105 is run through ground test in the aircraft.

New Business Search

Thus, finding new business is regarded by the company as its most serious near term problem. It recognizes the dangers of being tied heavily to any single military program, though the outlook for the F-105 at the moment looks firm through 1962, based on orders for 525 airplanes. This does not include another 400 which might be ordered for Tactical Air Command or foreign orders.

Laboratory for Electronics is working in several directions for broadening its operations:

• **Foreign business.** The company has negotiated with Fokker and also with companies in France and Italy for overseas business. This would include not only doppler systems for any foreign orders for F-105s and possibly avionic gear for the German F-104s, but also commercial business in the European Common Market.

• **Merger.** Though a recent proposal that it merge with Servomechanisms, Inc., was turned down by the company's board, a merger preferably with a West Coast company with electromechanical capabilities is still being actively sought. The Servomechanisms step fell through when its earnings failed to reach estimates in the negotiations.

• **New products.** The company has 500 of its 2,000 employes engaged in research and development. It is still interested in the computer field (its Computer Products Division volume was $1.9 million in Fiscal 1959) and supplies a magnetic storage drum to RCA for a data processing system. Under development is a storage disk using ferro-magnetic thin films which may have greatly increased storage capacity. Another device the company is developing is a Memetron tube, a cathode unit for displaying visually the data stored in data processing systems.

A report by the investment firm of Paine, Webber, Jackson & Curtis estimates the computer operation will bring the company $3 million this fiscal year and perhaps $25 million in five years. Based on five year forecasts of total volume of $100 million, this division may contribute 25% of sales and more than 50% of profits.

Maintaining Growth

Henry W. Harding, who was brought in as president in 1956, said that maintaining the sales growth curve is of key importance to the company's future. Even a flattening of the curve can have adverse affect, he pointed out. Among

other things, a steadily rising curve is important in attracting and holding the technical people the company must have to compete.

He estimates sales for this fiscal year will reach $35 million and earnings somewhere between $800,000 and $1 million.

An important financial factor in the company's life is David Rockefeller and the company is his only venture as a large individual investor, and not in conjunction with the family. A substantial holder of the company's common stock, he found himself locked in when the deficits appeared and to safeguard his investment found it necessary to put another $500,000 into the company's 6% cumulative preferred stock to keep the company operating in 1956.

Besides cutting out several unprofitable lines of instruments, including oscilloscopes, the new management has consolidated the company into one plant in Boston instead of the five it previously used. The plant is leased at a cost of $189,600 annually; the lease eliminated what otherwise would be a large required capital outlay.

Operations since have been strongly oriented toward obtaining prime contracts. Not only does this act as a safeguard against the normal tendency in times of contracting volume for the prime to pull back work into the house, but it has other advantages.

In the company's two doppler contracts mentioned earlier, there is also at least $7 million in spares business that will be added. These fringe benefits can help volume significantly, Harding points out.

The company has had some delivery and reliability problems and a reliability group was set up as a result. It found that 50% of its reliability problems on the doppler systems were simple failures of soldered joints, primarily a production line problem, not design.

New Offerings

Telechrome Manufacturing Corp., Amityville, N. Y., engaged in the manufacture and sale of telemetering equipment for guided missiles and industrial telemetering systems and commercial television equipment. Offering is $750,000 of 6% convertible debentures, due 1969 (convertible into shares of the company's Class A stock, 10 cents par value), for public sale at a price of 100% per unit. Underwriters have agreed to purchase from the company Class A stock purchase warrants, exercisable for a period of five years from date of issue, to purchase an aggregate of 10,000 shares. Proceeds will be used to retire bank notes; to pay the balance of the purchase price for 50% of the issued and outstanding capital stock of the Hammarlund Manufacturing Co., Inc.; for advances to Universal Transistor Products Corp.; for expansion of manufacturing facilities and the purchase of equipment and other corporate expenses.

Copperweld Steel Co., Pittsburgh, Pa., engaged in the manufacture of electric cable for avionics industries and tubing and tube assemblies for aviation support equipment. Offering is $8,000,000 of convertible debentures, due 1979, for public sale. Proceeds will be used to pay short term notes; balance will be added to the company's general funds and used, together with other funds, for the expansion and improvement of the company's manufacturing facilities.

Transitron Electronic Corp., Wakefield, Mass.; principal business the development, manufacture and sale of semiconductor products. Offering is a secondary, with 1,000,000 shares of outstanding common stock involved; price and terms to be supplied by amendment. Selling stockholders are David Bakalar, president, and Leo Bakalar, board chairman and treasurer, (who own an aggregate of 98.6% of the company's outstanding stock); each is selling 500,000 shares.

Mohawk Airlines, Utica, N. Y. Offering is $3,500,000 of 6% convertible debentures, due 1974; $1,917,500 to be offered in exchange for a like amount of the company's outstanding 5½% convertible debentures, due 1966; the remainder, plus any not taken in the exchange offer, to be offered for public sale. Proceeds will be used to pay indebtedness ($308,250); the balance to be added to the company's general funds. These funds, together with retroactive mail pay expected to be received, will be used to equip the company's aircraft with radar; for improving the air conditioning systems in its Convair aircraft; and for additional working capital and other general corporate purposes. Proceeds from the sale of any portion of the $1,917,500 of debentures not taken up in the exchange offer will be used, together with other funds, to redeem the remaining outstanding 5½% debentures (AW June 8, p. 36).

United Control Corp., Seattle, Wash.; principal business the design, manufacture, and sale of control systems, electronic equipment and accessory devices for military and commercial aircraft, missiles, space vehicles, and industrial uses. Offering is $2,500,000 principal amount of convertible debentures due Dec. 1, 1974, to be offered for public sale. Proceeds will be added to the company's general funds and will be used in the proposed plant construction program, and for increased research and development activity.

Bowmar Instrument Corp., Fort Wayne, Ind.; principal business the design and manufacture of electromechanical apparatus for aircraft and missiles. Offering is 78,000 shares of common stock, no par value, to be offered for public sale; 45,000 shares are being offered by the company and 33,000 shares by stockholders. Proceeds will be added to the company's general funds; a portion of the proceeds will be used to retire short-term loans, in the amount of $200,000, incurred for working capital purposes.

Anelex Corp., Boston, Mass.; principal business the design, development and manufacture of high speed printers for use in association with computers and electronic data processing equipment or systems. Offering is (1) $2,250,000 of subordinated debentures, due 1974, with warrants attached to purchase 45,000 shares of common stock, $1 par value; (2) 90,000 shares of common stock, $1 par value; debentures and stock to be offered in units consisting of $50 principal amount of debentures (with attached warrant to purchase one share of common stock) and two shares of common stock. Proceeds will be used to pay in full principal amount, plus accrued interest, of outstanding serial notes; to redeem and pay accumulated dividends on the 2,000 outstanding shares of cumulative preferred stock; to pay a promissory note to Anderson-Nichols & Co.; to be used for machinery and equipment, and the balance for general corporate purposes.

Acquisitions And Mergers

Heli-Coil Corp., Danbury, Conn., is offering 157,500 shares of its common stock, without par value, to the holders of outstanding shares of the capital stock, $10 par value, of Grip Nut Corp. The holders of 95.7% of the outstanding Grip Nut capital stock have entered into an agreement with Heli-Coil to exchange their holdings of 103,055 shares of Grip Nut stock for 150,850 shares of Heli-Coil's common stock. The agreement contains a representation that, except for 31,480 of the 157,500 shares, the Grip Nut stockholders have no present intention of selling any of the shares of Heli-Coil that they receive pursuant to the proposed exchange for a period of six months following the exchange; all or part of the shares of Heli-Coil's stock may be sold from time to time by any of the exchanging Grip Nut stockholders at prices current at the time of sale; Heli-Coil will receive no part of the proceeds of any of such sales.

Where EECo timing equipment counts

ELECTRONIC ENGINEERING COMPANY'S
List of major instrumentation timing contracts

- **AIR FORCE MISSILE TEST CENTER**
  - Atlantic Missile Range Dual Central Timing Signal Generator
  - Downrange Central Timing Signal Generators
  - Terminal Timing Signal Systems
  - On-Site Sub-Central Timing Systems
  - Ballistic Missile Launching Control System
  - Instrumentation Timing and Ballistic Missile Launching System
- **NAVAL AIR MISSILE TEST CENTER**
  - Instrumentation Timing System Study
  - Design and Development of Sea Test Range Timing System
  - Various Special On-Site Instrumentation Timing Signal Equipments & Systems
  - Launching Control System Design
- **AIR FORCE FLIGHT TEST CENTER**
  - Photographic Instrumentation Timing System Study
  - Design and Development of Camera Timing System
  - Design and Construction of Timing and Calibration Unit
  - Design and Construction of Recording and Distribution Systems for Timing Signals
  - Design and Development of Central Time Code Generator
- **NAVAL ORDNANCE TEST STATION**
  - Development of Test Vehicle Launching Control System
- **ROYAL CANADIAN AIR FORCE**
  - Central Timing System for Cold Lake Station
- **NATIONAL BUREAU OF STANDARDS**
  - Time Interval Selector
- **U.S.S. MISSISSIPPI**
  - Shipboard Missile Timing Equipment
- **U.S.S. NORTON SOUND**
  - Shipboard Missile Timing Equipment
- **ABERDEEN PROVING GROUND**
  - Time Code Generator
- **FT. HUACHUCA**
  - Timing System for Electronic Proving Ground
- **AEROJET-GENERAL**
  - Time Signal Distribution System (Pacific Missile Range)
  - Range Timing System (Pacific Missile Range)
- **DOUGLAS AIRCRAFT COMPANY**
  - Transistorized Airborne Time Code Generator
  - SADAP Timing System
  - Time Code Generator (Ground)
- **LOCKHEED AIRCRAFT CORPORATION**
  - Time Code Generator
  - Terminal Timing System
- **PHILCO CORPORATION**
  - Satellite Instrumentation Timing System
- **SYLVANIA**
  - Code Generator System
  - Time Code Generator

From the Atlantic to the Pacific whenever a missile leaves the launching pad odds are better than 5 to 1 that its instrumentation is being coordinated by timing signal systems made by Electronic Engineering Company of California. In the 10 short years since it first launched a basic study of timing, EECo has become the leading supplier of this type of equipment in the United States. This background of experience enables EECo to produce rapidly and economically the instrumentation timing systems and components so vitally needed for the space age.

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EE 9-9

Alloyd Explores Gyro Cleaning Technique

By James A. Fusca

Cambridge, Mass.—Substantial increases in the life of bearings for the highly precise gyroscopes in inertial guidance systems may result from a research program now under way at the Alloyd Corp. in collaboration with Massachusetts Institute of Technology's Instrumentation Laboratory. Alloyd, a company set up by personnel from the MIT faculty, has been studying the problems of precision bearing operation since 1956 and presently holds contracts totaling about $400,000 from the Navy and Air Force.

Abrasive Particles

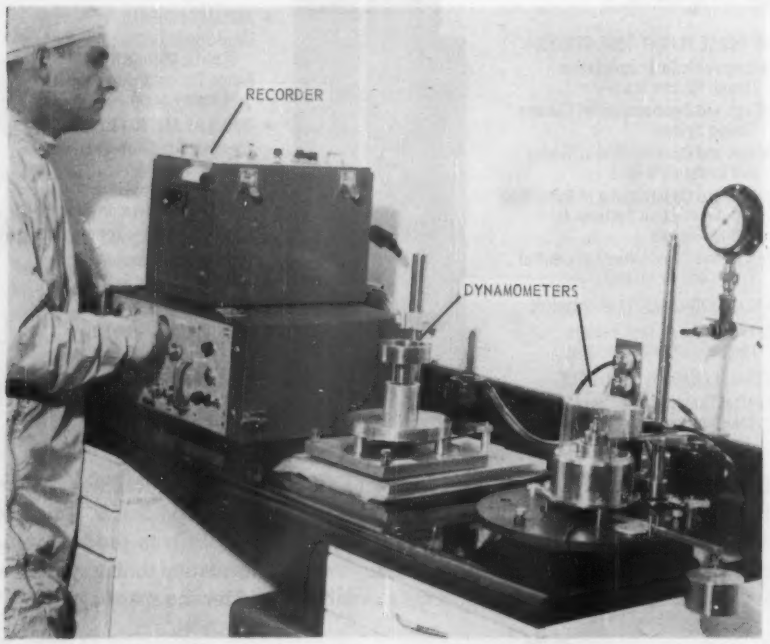
The company believes that it has demonstrated conclusively that a prime cause for the friction problems encountered with gyroscopes is contamination by abrasive particles of the gyros' precision bearings, and that it should be possible through proper cleaning techniques to markedly increase the life expectancy of these bearings. Additionally, it should become possible to run these bearings at higher preloads using new materials and possily with still less lubricant for longer periods of time than at present. This would improve gyro performance without adding the complications or a change to electrostatic or gas-supported bearing systems.

The method most commonly used at present to examine bearing components for dirt and foreign matter is visual inspection by means of a stereo-microscope at magnifications of 20 to 40 diameters with a standard white light source. In its investigation, Alloyd examined a series of failed bearings supplied by MIT's Instrumentation Laboratory. In attempting to improve the resolution of the inspection procedure used on bearing surfaces, various microscopic techniques were tried, such as dark field, interference microscopy, and the use of polarized light.

Polarized light microscopy proved to be the technique which provided the most useful information. Using polarized light, it was found that particles on the surface of the bearing—which were transparent and therefore invisible under other light sources—showed up distinctly. The light scattering properties of these particles indicate they must have a double index of refraction and must also be transparent or translucent. Later work indicated that these particles were either imbedded in the raceways and balls or held on by electrostatic attraction.

Comparison of these particles with materials used in finishing operations during manufacture of the bearings indicated that they must be grinding or lapping compounds. Samples of the compounds normally used in finishing of these precision bearings were examined and the sizes, shapes, and colors of these materials were found to coincide with those of the particles found in the bearings. To determine that this material was actually left in the bearing in manufacture rather than assembly, new bearings made by different manufacturers and of a variety of sizes were obtained and examined. Particles were found in all of the bearings inspected.

The technique of using polarized light has proved so sensitive that with practice it is possible to tell whether the finishing compounds are emery, Alundum or diamond. Alloyd considers that in view of the size and quantity of the particles found it could be considered surprising that they have not been seen earlier. The company points out, however, that these particles are obvious only under polarized light; under white light conditions they are completely invisible.



BEARINGS are examined in the Alloyd investigation by means of the experimental set-up shown above. Slow speed dynamometers spin the bearing (right) and the sensor output is amplified and displayed on the strip-chart recorder at the left.

Types of Failures

Gyro bearing failure is evidenced in several forms, such as:

- **Erratic behavior** caused by dirt contamination.
- **Failure through distortion** of retainers.
- **Slow but marked** increase in friction level with time, leading to sufficiently increased running torques so that in the extreme the gyro rotor cannot be kept at synchronization speed.

Failure of materials within the bearing is obviously serious, as is failure resulting from "rocky" contamination within the bearing. These defects, however, can be detected through the use of a slow-speed dynamometer which measures vibrations transmitted from a slowly spinning bearing, and from the traces on a chart it is possible to pick out defects in geometry, and lubrication and dirt contamination.

It is the friction increase type of bearing failure which is the most costly and which presents the greatest problem because it may take place over a long period of time. This form of failure as evidenced by a delayed increase in running torque is termed a lubrication failure, and bearings which

were examined after such a failure invariably showed a heavy layer of varnish deposited within the raceways.

With the discovery that ground surfaces can be contaminated with abrasive materials, Alloyd theorized that the means of forming the varnish which causes the lubrication failure is by polymerization of the lubricant. It has been known for some time that a clean, or oxide-free, metal surface can act as an excellent catalyst for the polymerization of oils—and the action of abrasive particles in the raceways is to make just such clean surfaces. The immediate solution to this problem would then be to remove the abrasive contaminant.

Cleaning Tests

Alloyd, working in cooperation with members of MIT's Instrumentation Laboratory, has conducted a series of tests covering all kinds of cleaning operations. A large number of solvents were tried either alone or in an ultrasonic cleaner, but none was entirely successful. One reason was that while some of the particles were actually embedded in the steel, others were held to the surface by electrostatic attraction. Wiping merely moved them from one place to another on the bearing.

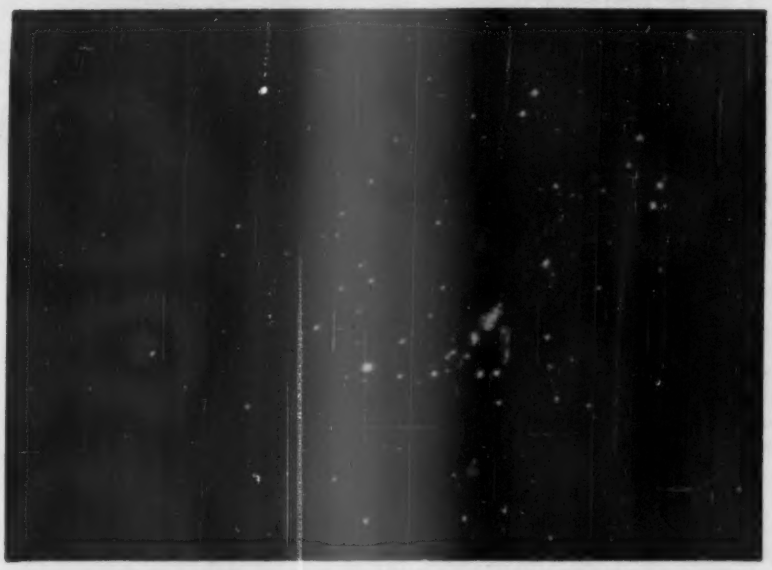
The only effective cleaning technique uncovered to date has been the application of a swab etch by means of a 1% nital solution. Recognizing that there might be some detrimental effect to the surface of the bearing from this kind of etch, a series of tests is now being performed at MIT on bearings cleaned with this method. These tests are aimed at determining if the long life expected from "clean" bearings can in fact be obtained in actual use. Preliminary results indicate bearing life will positively be substantially extended.

Contamination Sources

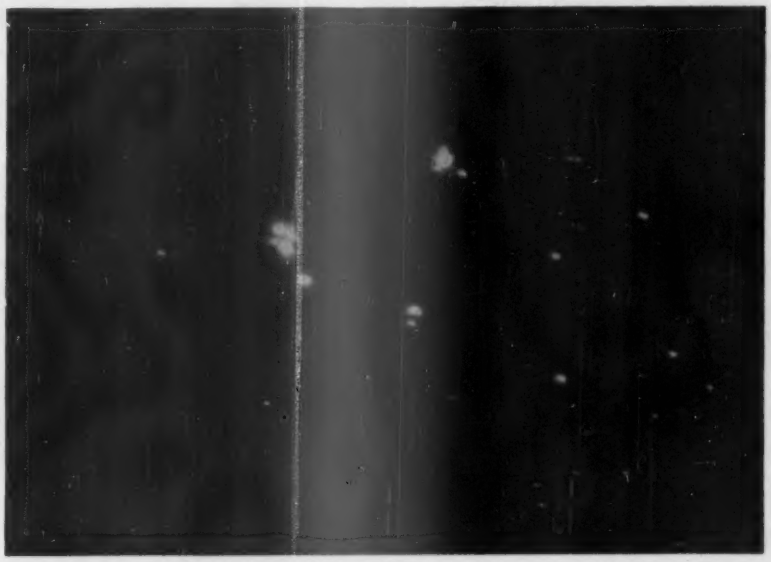
A corollary to this work was the discovery that other sources can contribute abrasive contamination material besides the compounds used in the lapping and finishing processes. For example, it was discovered that since the plunger of a hypodermic needle assembly generally is lapped in place with a grinding compound, using a hypodermic needle to oil a bearing leads directly to contamination by abrasive material.

Another source of contamination is the lubricant itself. It is common practice to process the lubricants used in these gyros through ceramic filters, sometimes as many as three or four times. Alloyd uncovered the fact that a relatively large supply of lubricant which had been filtered in this manner was thoroughly contaminated with abrasive material coming from the filters themselves.

AT 200 X magnification, precision ball bearing shows dimples from finishing operation.



WITH same field as top photo, polarized light shows contaminant particles as shiny dots (above). Photo below shows particles on unlapped inner race under polarized light.



Puerto Rico Radar Construction Set

Ithaca, N. Y.—Ionization effects of ballistic missile travel through the upper atmosphere and radio astronomy studies will be conducted by Cornell University with a 1,000 ft. diameter radar facility in Puerto Rico.

The $4.5 million radar facility, to be financed by the Advanced Research Projects Agency (AW Nov. 16, p. 115), is expected to be fully operational within two years from the time construction begins in February, 1960. Test borings are now in progress by the Army Corps of Engineers at the site, a natural bowl of coral limestone.

The fixed radar antenna will be a 1,000 ft. diameter parabolic dish with a 600 ft. high tripod supporting the feed antenna. The stationary antenna will be able to swing its beam only 20 deg. from the vertical, affording a beam sweep of 40 deg. Despite the limited beam sweep, the location of the installation at Puerto Rico provides an equatorial latitude (18 deg. N) for access to the solar system and to the Atlantic Missile Range.

Peak power of the radar will be 2.5 mw. and the transmitting frequency will be from 420 to 440 mc. The low frequency, long wave length signal will not provide the resolution of the U. S. Navy Radio Research Station at Sugar Grove, W. Va., which will be capable of operating at much higher frequencies. Nor will the fixed radar facility be of value for space vehicle tracking.

Cornell has established a Radiophysics and Space Research Center which will operate the large radar under ARPA contract. Directing the center will be Prof. Thomas Gold, a British cosmologist known for his work with Herman Bondi on the theory of continuous creation of matter.

The radar will measure electron density and electron temperature at different heights and times in the ionosphere. Additionally, it may measure ionization and detect transient streams of aurorae-charged particles from outer space in connection with the phenomenon, and explore the existence of ring current.

The installation is believed capable of receiving radar echoes from the moon, Venus, Mars, Mercury, the sun and possibly Jupiter. Gold asserted that there may be a relatively high density of atmosphere before solidity occurs on the surface of Jupiter. If no signal is obtained, science will know that Jupiter is shrouded in a deep atmosphere that dissipates radio wave's strength.

Jupiter, at its closest point, is about 400 million mi. from earth. The current maximum distance that a radar echo has been received is the Jodrell Bank, England, radar bounce off Venus at a distance of 30 million mi.

Soviet Radio Telescope in Armenia

Photograph shows part of what appears to be a large linear array which is one portion of the largest radio telescope known to exist in the Soviet Union. Telescope is located near Burakan, in Soviet Armenia. Fixed radio telescopes such as this utilize the earth's rotation to scan a section of sky along the equatorial plane, and can employ interferometer techniques to improve resolution.

Burroughs Wins ALRI

Burroughs Corp. won Air Force competition for Airborne Long-Range Input (ALRI) contract (AW Nov. 2, p. 23) which, in the first stages, will total about $35 million and will run 42 months.

ALRI is a radar station housed in a Lockheed RC-121 reconnaissance aircraft which will provide seaward extension of the SAGE system. Burroughs has previously been awarded approximately $124 million in SAGE contracts.

About 50-60% of Burroughs' work on the ALRI project will be subcontracted, including flight-testing of airframe portions and some parts of communication and navigation equipment.

FILTER CENTER

▶ **Ultra-High-Speed Computers**—Digital computers that operate at computing speeds of 1,000 mc. may be achieved in the next decade using microwave phase-locked oscillators as the basic computing element, according to G. B.

He put a new twist in an old trick

His problem was to take a 3"x6"x 3-foot piece of wave guide tubing made of .08-inch thick aluminum and to twist one end 90° to the other *without buckling or stretching any part of it...so that a cross section taken anywhere along its length remained a perfect rectangle.*

The standard solution for a problem like this: Support the tube internally with a solder-like substance that's melted in, cooled, melted out after twisting. It won't work here because the mass of the substance is too great.

Here's how this AMF production engineer found the answer. First, he visualized the concept that, in any symmetrical twist, *the center axis never moves.* Then he applied this concept by stringing a metal rod through the center of 288 rectangular shims, inserted them in the tube, cushioned them with the same solder-like substance. Jaws clamp on either end. One of them rotates *slowly* (twisting time: over 2 minutes) giving the metal time to flow. The result: Perfect twists, every time.

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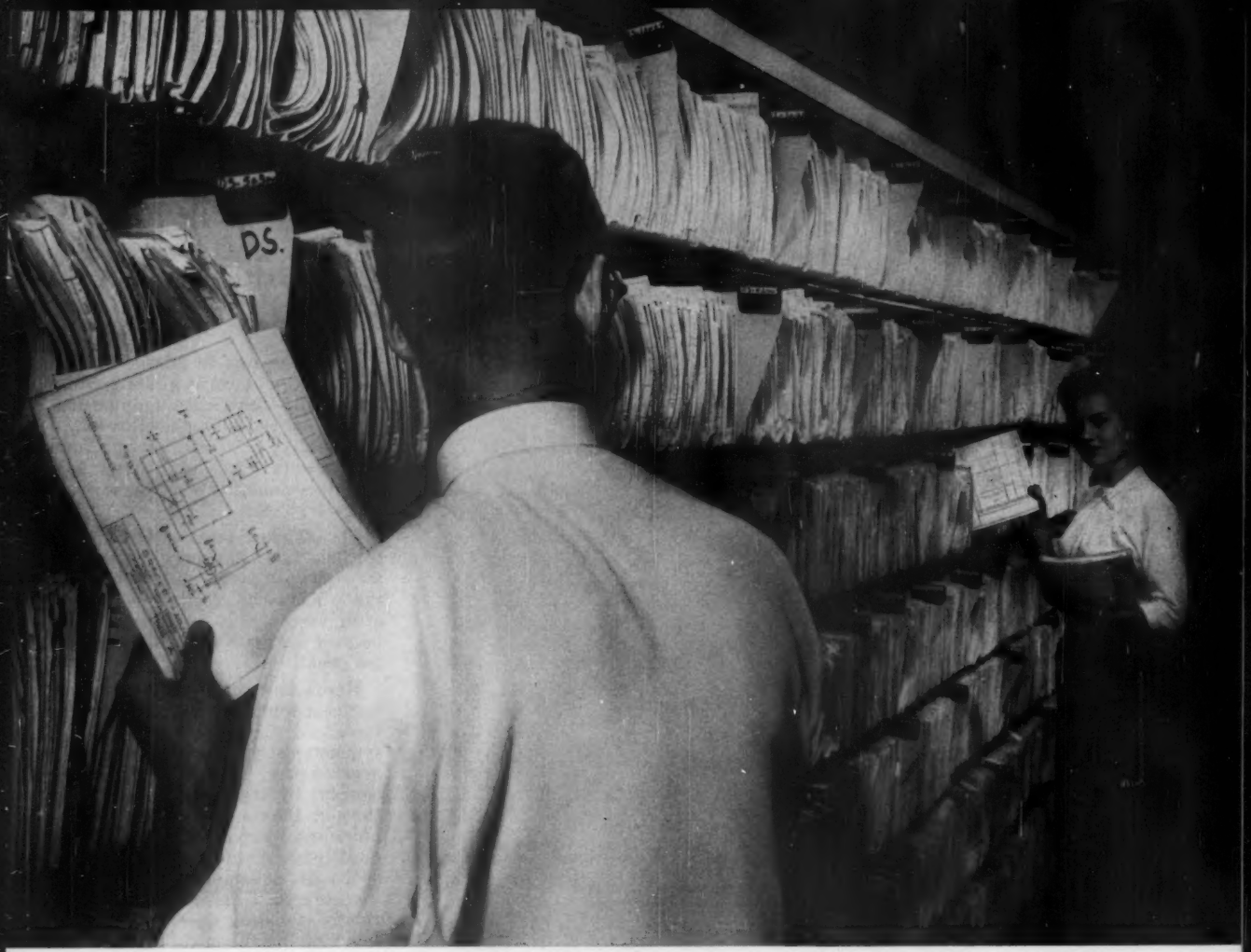

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Plastic Radar Reflector for Tartar

Plastic radar reflector being assembled at Republic Aviation Corp. plant in Farmingdale, N. Y., will be tied in with Tartar missile system on U. S. Navy ships. Reflector is 8 ft. in diameter, weighs 325 lb. and can withstand shock load of 160,000 lb.

Herzog, Radio Corporation of America. RCA is investigating, under Navy Bureau of Ships sponsorship, the technique in which the digital "1" or "0" is represented by the phase of the oscillator signal.

So far, RCA has performed simple computer functions at a 100-mc. rate, and improved design oscillators have been switched at 230 mc., according to Herzog. RCA uses printed circuit wave guide and a special variable-capacity junction diode for its oscillator. Although operation at microwave frequencies poses new computer design problems, it has certain advantages in addition to speed. For example, signals can be combined in passive structures to perform certain logic operations, such as inversion of phase script by 180-deg. delay of the carrier. Hybrid ring and ferrite isolators can be used to give information directionality which is not possible in basic two-terminal negative resistance amplifiers, Herzog says.

▶**Navigation Aid Spoofer**—Countermeasures system designed to detect presence of enemy low-frequency navigation system radiation, rapidly analyze its characteristics and then transmit jamming or deception signals, is being developed for Army Signal Corps by Emerson Radio & Phonograph Corporation's Government Electronics Division.

▶**High Temperature Thermometer**—Platinum resistance thermometer, for interpolating between fixed points on the International Temperature Scale between 630 and 1,063C has been developed by National Bureau of Standards. New instrument is accurate to within a few tenths of a degree in this upper temperature range, NBS reports.

▶**Miniature Data System**—Miniaturized solid-state airborne data aquisition system, developed by Gulton Industries, weighs 7 lb., occupies 230 cu. in., consumes 15 watts power, can monitor up to 30 analog voltage inputs and convert each to binary-coded decimal output at rate of 120 samplers per second. Output is transmitted in parallel-serial fashion with a parity check. New device provides conversion accurate to within 0.25%, or to within 0.1% as an optional feature, over temperature range of 0 to 75C.

▶**Dielectric Anyone?**—Digest of Literature on Dielectrics, Volume 22, published by National Academy of Sciences-National Research Council, is now available from the Printing & Publishing Office, National Academy of Sciences, 2101 Constitution Ave. N. W., Washington 25, D. C. Price is $5.00.

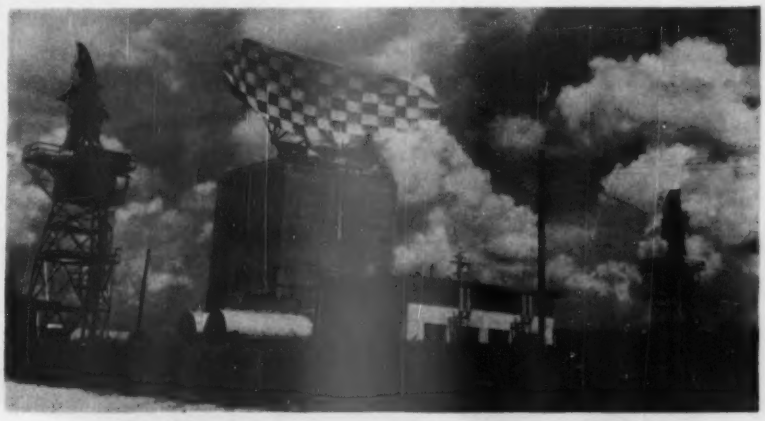
▶**Telemeter Magnetics, Inc.**, Los Angeles, has been awarded a contract to develop airborne digital programers for Project Vega. The $400,000 contract covers development and manufacture of the airborne units plus ground-based checkout systems.

▶**Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

• **Melpar** will develop and fabricate five two-way digitalized speech bandwidth compression systems for USAF's Wright Air Development Center under $550,800 contract.

• **Stromberg-Carlson Division** of General Dynamics Corp. will develop completely transistorized single sideband communication system for Navy Bureau of Ships under a $1.2 million contract. Equipment will be used for ship-to-ship and ship-to-shore communications.

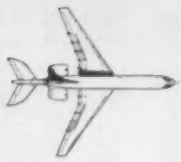
• **North American's Autonetics Division** will design, build and flight test a fully automatic all-weather landing system, including final approach, touchdown



SAGE Antenna at Alabama Site

Air Force AN/FPS-35 search radar at Thomasville Aircraft Control and Warning Site, Ala., was developed by Sperry Gyroscope Co. and is part of SAGE network. Tower is 85 ft. high and antenna weighs nearly 70 tons. Facility is self-contained.

THE SHAPE OF THE FUTURE...



The wing is free to do its job

because...

the engines are in the right place

Here is *the* aircraft design of the future—with its clean, uncluttered wing and *rear-mounted* engines. Among its many advantages:

- Wing has higher lift and lower drag—assuring superior airfield performance and better high mach characteristics
- Full-span leading edge lift devices and uninterrupted flaps
- No tanks or fuel lines in turbine disc areas
- Better performance margins and unique payload/range capabilities
- Greatly reduced cabin noise—throughout
- No handling problems in critical "engine out" situations
- High-set engines practically eliminate debris intake risk
- Simpler maintenance from better systems access
- Reduced engine mounting structural difficulties

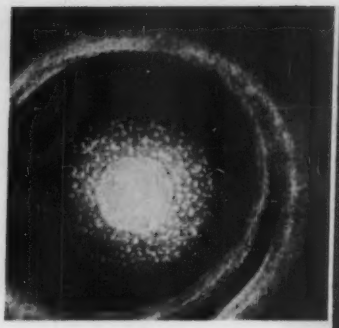
With all these—and many other—advantages, *rear-mounted* engines represent a momentous step forward in jet age design.

For complete data, contact Christopher Clarkson, U. S. representative, 10 Rockefeller Plaza, New York 20, N. Y.

VICKERS VC 10

Four rear-mounted Rolls-Royce Conway By-Pass Turbojets

Vickers-Armstrongs (Aircraft) Ltd., Weybridge, England • Member Company of the Vickers Group



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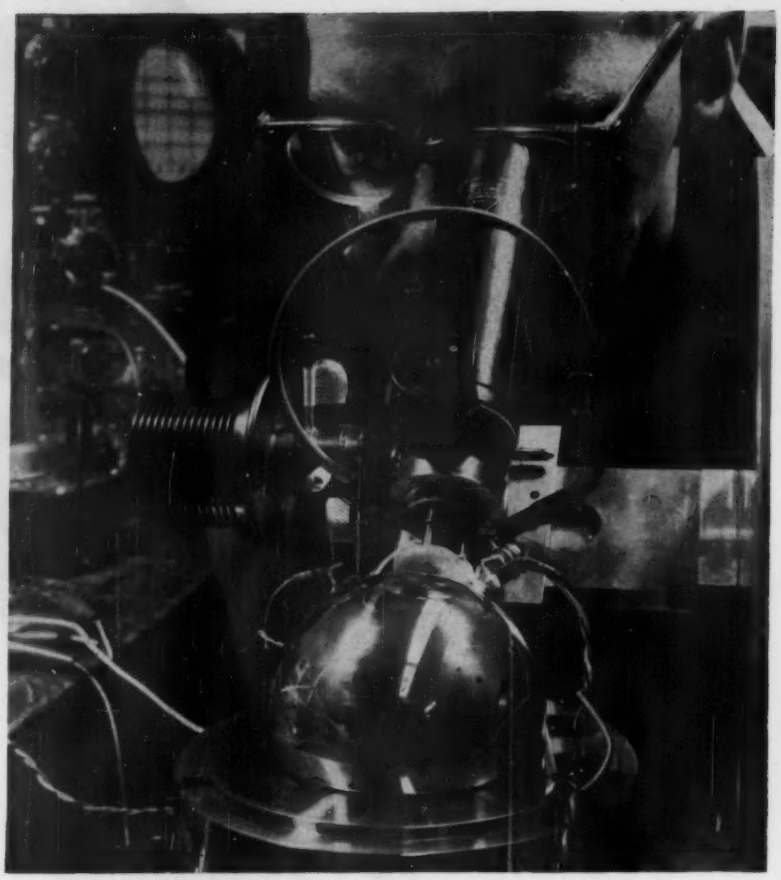


Beryllium Ball Used in Gyroscope

Ball of beryllium, a key unit in a new gyroscope being developed by Minneapolis-Honeywell, is designed to spin at high speeds while held in position in a vacuum by electrical forces. It thus will spin without being slowed by friction.

and runway landing roll, under $422,000 award from Wright Air Development Center's Flight Control Laboratory. After Air Force tests, the AN/APN-114 (XA-1) system will be delivered to Federal Aviation Agency in Atlantic City, N. J., for evaluation. (For details on the Autonetics system, see AVIATION WEEK, Oct. 5, p. 113.)

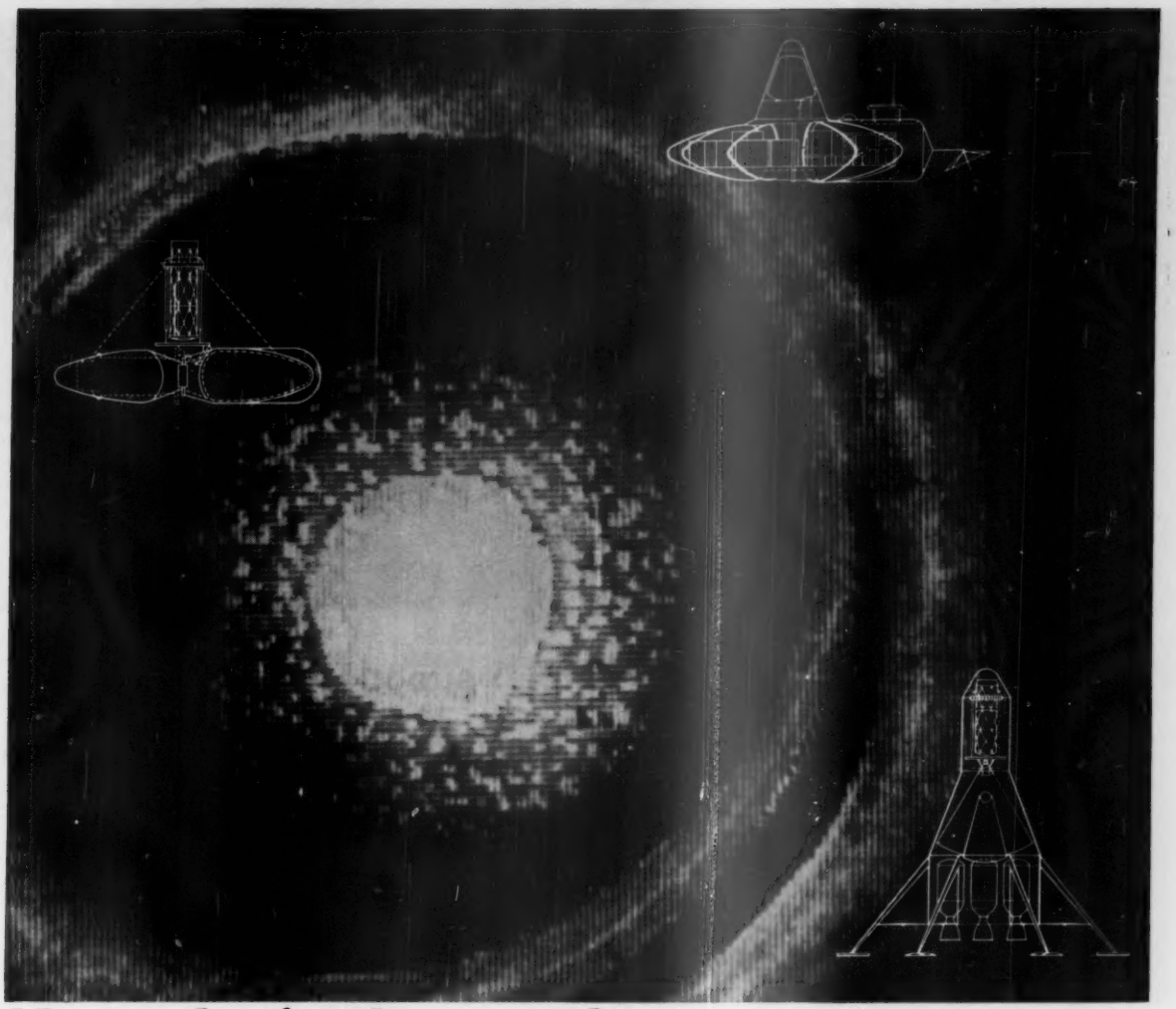
• **National Cash Register Co.,** Electronics Division, Hawthorne, Calif., will continue its study of super-fast magnetic rod switching and storage devices under $70,000 contract awarded by Air Force Cambridge Research Center. The magnetic rod, which measures approximately 0.015 in. in diameter, has exhibited switching speeds as small as 4 milli-microseconds, company says.

• **Bendix Aviation International Division** reports a contract for nearly a million dollars for avionics equipment to be used on West German Air Force aircraft. Equipment, to be built by Eclipse-Pioneer and Bendix Radio, includes transistorized navigation unit, glide slope receiver, transistorized VHF receiver and a marker beacon receiver.

• **Telecomputing Corp.,** Los Angeles, will produce gyro systems for Nike Hercules missile under $1.6 million contract awarded by Western Electric.

Collins Radio Earns Profit for Fiscal 1959

Collins Radio Co. reported a net profit of $3,718,817 in its fiscal year ended July 31, compared with a net loss of $256,749 the year before. Sales rose from $107,569,379 to $117,864,139 and backlog from $133 million to $210 million, including $30 million in commercial and foreign orders. The previous year's loss had resulted partly from sharp cost increases on contracts taken at the time of the Korean war. Better government scheduling, inventory adjustments as the result of contract completions and closer cost control produced the more favorable results for Fiscal 1959.



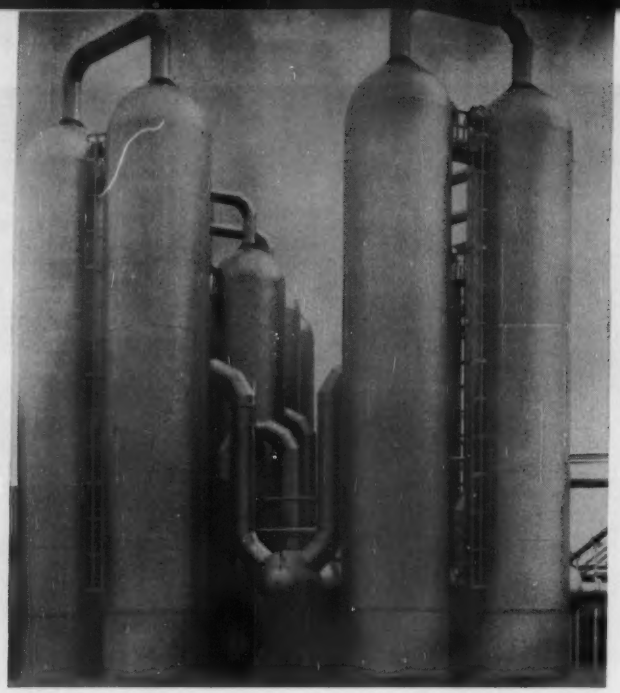
New styles for the man-about-space

Every time a space traveler leaves home (earth), he has to wrap himself in the complete environment necessary to his physiological and psychological well-being. Styling sealed space capsules to suit man's every requirement has been a major project at Douglas for more than ten years. Forty basic human factors areas were explored in these studies. Now Douglas engineers have evolved plans for practical space ships, space stations and moon stations in which men can live and work with security thousands of miles from their home planet. We are seeking qualified engineers and scientists who can aid us in furthering these and other out-of-this-world but very down-to-earth projects. Some of our immediate needs are listed on the facing page.

Dr. Eugene Konecci, Head, Life Sciences Section, reviews a new concept in space cabin design with Arthur E. Raymond, Senior Engineering Vice President of

DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT



AIR

for supersonic wind tunnel supplied by pressure tanks built of USS "T-1" Steel

It takes vast quantities of high pressure air to create a supersonic wind. These 12 tanks supply air at 600 psi to a 20-inch supersonic blow-down wind tunnel at NASA's Langley Aeronautical Laboratory, Langley Field, Virginia. They were designed and built of USS "T-1" Constructional Alloy Steel by Pittsburgh-Des Moines Steel Co. Each tank is 63 feet high by 11 feet in diameter.

With total volume, pressure and available ground area specified, the problem in this design was to determine the most economical size and number of tanks to do the job. If made of standard boiler steel, the tank walls would have had to be nearly three times thicker than the 1¼" made possible by USS "T-1" Steel. With this three-times-stronger alloy steel, the tank heads are only ⅝" thick, compared with a requirement of nearly 2" thick if made of lower-strength material.

These vessels are good examples of the savings possible with high yield strength USS "T-1" Steel. Much less steel was required; there were vast savings in welding, foundation and volume—and, very important because of space limitations, there was a large reduction in ground area required. The vessels were designed to a working stress of 40,000 psi and 90% joint efficiency. The tensile strength of USS "T-1" Steel for pressure vessel applications is now a full 115,000 psi.

How USS "T-1" Steel saves. These vessels required much less steel than normally used — so there was a sizeable reduction in freight costs. They required less material for foundations. Volume of weld metal was also drastically reduced. And they saved ground space in an area where available space was limited.

Why not find out what USS "T-1" Steel can do for you? Write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS and "T-1" are registered trademarks

United States Steel Corporation—Pittsburgh
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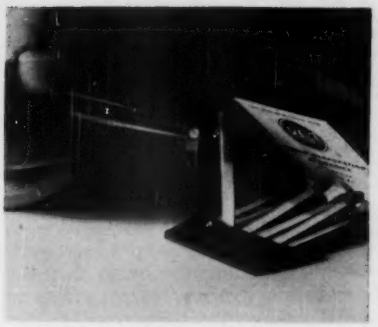
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel



Tunnel Diode

Tunnel diodes are now being offered on a sampling basis to avionic manufacturers by the RCA Semiconductor and Materials Division. Photo above shows size of the new diode in its low inductance case.

Stock Transactions

Transactions for the periods July 11, Aug. 10 and Aug. 11-Sept. 10 include:

Robinson Technical Products. Disposition of 1,800 common shares by Thomas D. Neelands, Jr., officer and director, leaving a holding of 13,305.

Ryan Aeronautical Co. Acquisition of 1,500 common shares through exercise of option by G. W. Rutherford, officer, making a holding of 1,500.

Seaboard & Western Airlines, Inc. Disposition of 1,000 common shares by Arthur V. Norden, officer, leaving a holding of 33,460.

Servomechanisms, Inc. Disposition of 1,680 common shares, his total holding, and $2,000 of 5% convertible debentures, his total holding, by Najeeb E. Halaby, officer and director.

Siegler Corp. Disposition of 1,000 common shares by Edward H. Heller, director, leaving a holding of 18,593; disposition of 500 common shares by Donald Royce, director, leaving a holding of 8,461.

Stanley Aviation Corp. Acquisition of 2,500 common shares through exercise of option by Richard H. Frost, officer and director, and disposition of 100 common shares, leaving a holding of 4,507.

Texas Instruments Corp. Disposition of 200 common shares by W. D. Coursey, officer, and acquisition of 2,000 common shares through exercise of option, making a holding of 7,005; acquisition of 100 common shares by E. O. Vetter, officer, making a holding of 4,888.

Thiokol Chemical Corp. Disposition of 500 common shares by H. W. Ritchey, officer, leaving a holding of 8,311.

Thompson Ramo Wooldridge, Inc. Disposition of 600 common shares by Burton F. Miller, officer, leaving a direct holding of 4,057 and an indirect holding of 9,000; disposition of 6,500 common shares by V. G. Nielsen, officer, leaving a holding of 3,738; acquisition of 3,400 common shares by Horace A. Shepard, officer, making a holding of 4,400.

Trans World Airlines, Inc. Acquisition of 100 common shares by Frederick G. Betts, officer, making a holding of 200.

United Air Lines, Inc. Disposition of 800 common shares by R. F. Ahrens, officer, leaving a holding of 4,575; disposition of 1,400 common shares by R. E. Johnson, officer and director, leaving a holding of 2,592; acquisition of 460 common shares by Eric Johnston, director, making a holding of 4,860; disposition of 400 common shares by Hal E. Nourse, officer, leaving a holding of 2,231; disposition of 3,200 common shares by Leonard S. Hobbs, director, leaving a holding of 400.

High Temperature KLIXON PRECISION SWITCH

Operation you can rely on even at 800°F.

Maintains operating characteristics at maximum temperature — Will not lose its snap action, "skip," or fail to actuate at 800°F.

"Surity-of-make" with dry circuit applications — Completely inorganic components mean no contact surface contamination due to out-gassing of organics at high temperatures.

Saves space and weight — Miniature size . . . weighs about an ounce.

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Assured longer life expectancy — Over 25,000 cycles at 800°F. The simple, one-piece sine blade eliminates knife edges and high friction points.

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Movement Differential	0.005", max.
Release Force	0.2 lbs., min.
Operating Force	0.5 to 1.5 lbs.
Current Rating	5 amperes, 30 VDC, resistive
Contact Arrangement	S.P.D.T.
Vibration Resistance	20 G's, 25 to 2,000 CPS
Shock Resistance	100 G's

For more information on the new KLIXON High Temperature Precision Switch, write for Design & Development Bulletin, DD-PRSW-9.

Western Manufacturers — refer inquiries directly to Metals & Controls' Southern California Office . . . 232 North Lake Avenue, Pasadena, California . . . Telephone: Ryan 1-4288.

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Competition Rises in Ion, Plasma Fields

By Philip J. Klass

Washington—Growing activity and encouraging progress in the development of electric propulsion techniques to power rocket-launched, large-payload vehicles on interplanetary missions and/or to shift satellite orbit, were reported here during recent meeting of the American Rocket Society.

The meeting also revealed the sharp competition between ion and plasma propulsion techniques, reminiscent of the rivalry between liquid and solid-propellant rocket engines. Most observers agree that it is too early to predict whether one technique will win out and many believe that both probably will find space propulsion roles.

New Developments

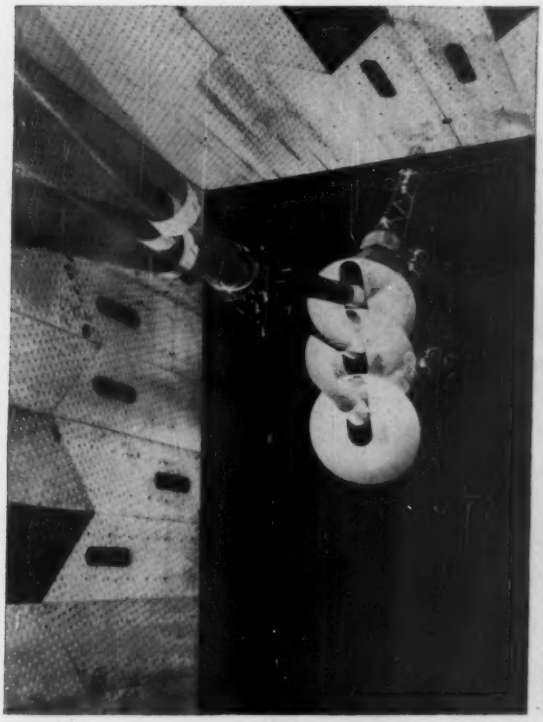
Here are some of the recent electric propulsion developments cited by ARS speakers:

• **Collinear electrode plasma accelerator,** developed by Lockheed's Missile and Space Division, has demonstrated an effective specific impulse of more than 2,000 sec., based on measured impulse and propellant mass. Lockheed has achieved maximum particle velocities of 80,000 meters per second and impulses of nearly 2,000 dyne-seconds, according to S. W. Kash and W. L. Starr of Lockheed's Ionic Physics Department. Efficiencies of more than 30% have been achieved under some conditions and a figure of 50% appears possible. Using plasma produced by electrode erosion, Lockheed scientists predict that effective specific impulses of 6,000 sec. should be realizable.

• **Cesium ion motor,** developed by North American's Rocketdyne Division, has achieved beam power level of 177 watts per square centimeter of ionizer area, with thrust levels of 5.6×10^{-4} lb./sq. cm. Mass utilization studies indicate that 70% of the cesium reaches the collector in the form of high energy ions and that over 90% was ionized at the surface ionizer. To neutralize the ion beam, electrons were injected by a thermionic emitter near the motor's exit aperture with the electrons being accelerated by the ion beam space charge, according to report presented by C. R. Dulgeroff of Rocketdyne and R. C. Speiser and A. T. Forrester, now of Electro-Optical Systems, Inc., Pasadena.

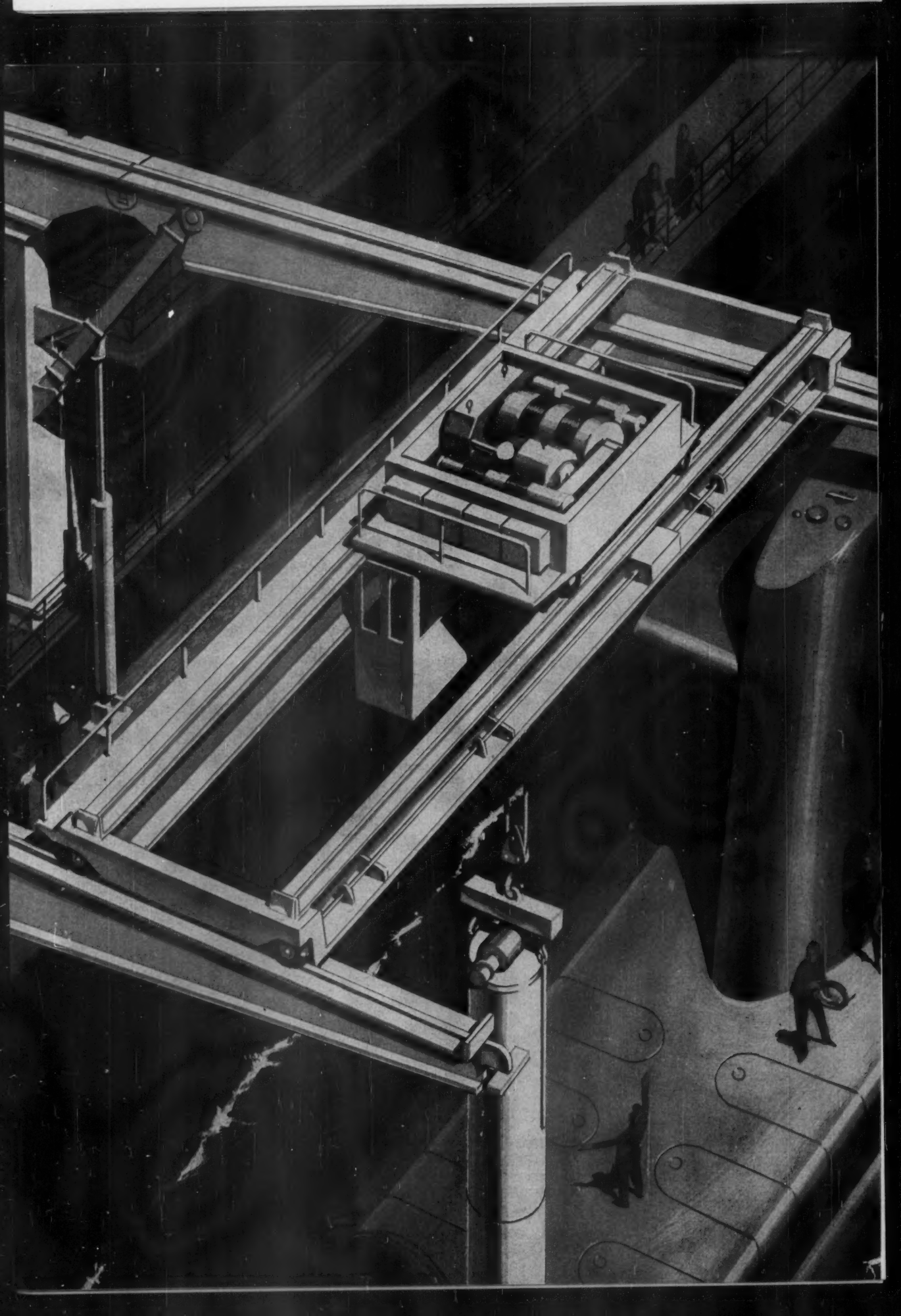
• **Arc-jet engine** using hydrogen has achieved specific impulse of 1,500 sec. in experiments at Giannini Plasmadyne Corp., according to a report by A. C. Ducati and G. L. Cann. The Plasmadyne scientists report that motors with radiative and regenerative cooling, designed to enable electrodes and nozzle to operate at temperatures over 1,000C, are now being designed. Work to date indicates that pressure in the arc chamber should be one atmosphere or higher to achieve reasonably good efficiency in converting electrical energy into effective jet kinetic energy.

• **Experimental ion engine** now in operation at Electro-Optical Systems, Inc., which operates either with cesium or potassium as the propellant, has achieved beam currents of 12 ma. and



Mercury Tunnel Tests Under Way at AEDC

Multiple-exposure photograph of 32% scale Mercury capsule model was taken during wind tunnel tests at U. S. Air Force's Arnold Engineering Development Center's transonic test section. Data is gathered in transonic speed ranges from Mach .5 to 1.5. The model at right shows the capsule at a 50 deg. angle in AEDC's Gas Dynamics facility. Run lasts for about $\frac{1}{10}$th sec.; smaller model at lower portion of the photo records measurements for purposes of comparison. Calibration probes are faintly visible.



Threading the needle with a POLARIS missile using Westinghouse Load-O-Matic controls

Easing POLARIS missiles from a tender into the launching silo of an atomic submarine takes a handling system that combines ruggedness with extreme maneuverability and safe, sure, precision control—control so sensitive that the POLARIS seems to float in the air as it swings smoothly and gently into position in the submarine.

Westinghouse Load-O-Matic* crane control system was selected by Skagit Steel and Iron Works[1] for this exacting and delicate handling operation because of its unerring vernier precision performance. The combination of hoist, bridge and trolley controls operating with almost microscopic accuracy nullifies the pendulum-like swaying of the load. These positive, stepless speed controls provide movements at less than one foot *per minute*, yet will accelerate smoothly up to two feet *per second*.

The exclusive Westinghouse features which permit such precision also provide maximum reliability and minimum maintenance. Static controllers, saturable reactors and magnetic amplifiers provide stepless control and eliminate moving parts, mechanical relays and switches which corrode, wear out and require frequent maintenance. The marine-insulated a-c wound rotor motor adds additional reliability and further reduces maintenance.

Whatever your requirements for missile handling equipment—drive systems for launchers, erectors, shelters, loaders, or shockproof equipment for hardened sites—take advantage of the Westinghouse engineering knowledge, experience, range of products and unit responsibility for any type of electromechanical system. Contact your Westinghouse sales engineer or write: Westinghouse Electric Corporation, 3 Gateway Center, Pittsburgh 30, Pa.

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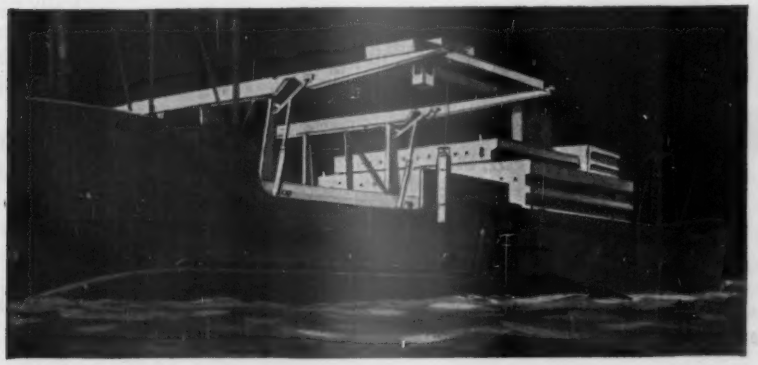

*Trade-Mark
[1]Located at Sedro Wooley, Washington.

J-92031

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Measure angular acceleration accurately

ANSWER:

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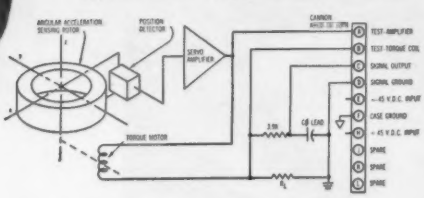
High natural frequency

THE FACTS... As you are well aware, designing a good angular accelerometer is a tough technical task. Donner Scientific's new unit is another successful chapter in a record of creative engineering.

Chief applications for this unique force balance angular accelerometer are closing the servo loop on ground launching equipment for missiles and detecting the roll, pitch and yaw accelerations of missiles once they are airborne. In the latter application, the Model 4525 can replace some gyros and supplement others.



Operational diagram of Donner's new Model 4525 Angular Accelerometer.

Donner's rugged new angular accelerometer weighs only 2 pounds.

The Specs

RANGES AVAILABLE
From ±1 radian/sec² to ±50 rad/sec² to any intermediate range.
FREQUENCY RESPONSES
±1 rad/sec² 30 cps natural frequency (90° lag)
±10 rad/sec² 100 cps natural frequency (90° lag)
OUTPUT, FULL SCALE
±20 volts across a 12,500 ohm load
RESOLUTION 0.01% full scale or better
LINEARITY 0.1% full scale
HYSTERESIS Less than 0.01% full scale
DAMPING 0.6 ± 0.1 of critical
SIZE 3.7" diameter x 3.7" high
WEIGHT 2 pounds

The mechanically rugged and electronically rigid Model 4525 is one more basic technical contribution from an engineering team specializing in inertial systems interlocking time, acceleration, velocity, and other dynamic inputs.

MORE DATA AVAILABLE—An illustrated 4 page data file is yours for the asking. Please address Dept. 0512.

DONNER SCIENTIFIC COMPANY
CONCORD, CALIFORNIA

Electric Propulsion for Space

Electric propulsion for space vehicles achieves a very high specific impulse by using a propellant of low mass which is accelerated electrically to extremely high velocities. Several basic types now under investigation, as reported at recent American Rocket Society meeting, include:

- **Ion propulsion employs propellant consisting of a stream of positively charged ions. These are shaped into a beam and accelerated by electrostatic fields using techniques similar to those employed in a cathode ray tube to form and direct beam of electrons. To prevent build-up of negative charge on space vehicle and to prevent blocking effect due to space charge, electrons must be injected into ion beam as it leaves space vehicle to neutralize its charge.**
- **Plasma propulsion uses a neutral (no-charge) plasma of propellant which is accelerated and directed by means of external magnetic fields which react with field produced by current flowing through the plasma. Technique involves many of the same principles under investigation for controlled fusion power.**
- **Arc-jet propulsion uses an electric arc discharge to produce sudden heating of propellant gas which expands in a suitably shaped nozzle to form a high velocity jet. This type of engine does not use external magnetic fields to augment propellant velocity.**
- **Heated gas propulsion employs a gas, such as hydrogen, whose energy level is raised by passing it through an electrically heated tungsten heat exchanger.**

a thrust of 68 dynes, when operated with potassium, Samuel Naiditch reported. Company has developed new technique for controlling and measuring amount of alkali vapor flux fed to the ion chamber in which the vapor is electrolytically diffused through a membrane.

• **Both ion and plasma engine** techniques are under investigation by the National Aeronautics and Space Administration's Lewis Research Laboratory in Cleveland. Primary emphasis is on the ion engine, because its operation is better understood and performance is more readily predicted, according to NASA scientists W. E. Moeckel and W. D. Rayle. However, there is strong interest in plasma investigations.

Propulsion Principles

Although proponents of ion and plasma engines disagree on many points, there is general agreement that at the present time the principles of ion propulsion are better understood than those for plasma propulsion. Design of an ion engine can draw on existing know-how developed for the design of electron and microwave tubes. The design of a plasma engine is much more dependent upon extensive laboratory experimentation because of the present inability to predict the complex interactions between magnetic-electric fields and the plasma.

It also is generally conceded that an ion engine can produce a higher specific impulse than a plasma engine, because it can accelerate particles to higher velocities. (Specific impulse is a measure of the thrust achieved per pound of propellant per second.)

However, Lockheed's Kash and Starr, both proponents of plasma engines, point out that there is another important factor to consider—the total thrust developed per unit area, referred to as "specific thrust." A low specific thrust involves a weight penalty because of the additional structural supports, propellant feed lines and radiating surface required.

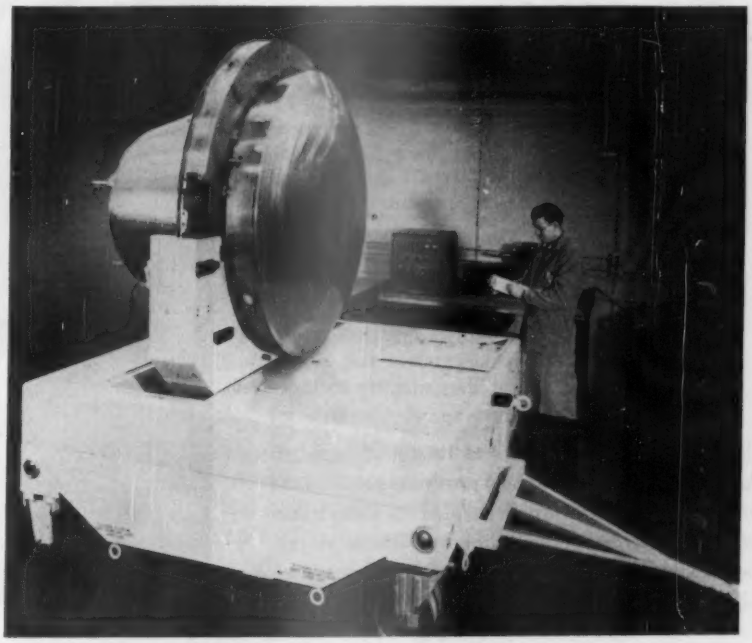
The Lockheed scientists point out that a plasma engine has a specific thrust that is at least 100 times greater than that of an ion engine because of inherent limitations imposed by voltage breakdown considerations in an engine that uses electrostatic fields for particle acceleration.

However, a report by David B. Langmuir of Thompson Ramo Wooldridge and Bernard R. Cooper of the University of California at Berkeley suggested that the specific thrust of an ion engine can be increased through the use of a series of accelerating electrodes, each of which contributes to the total thrust. They concede that there are many "formidable practical difficulties associated with (these) concepts," but they believe the potential gain may justify further investigation. Added advantage of the technique is the ability to achieve useful thrust levels with a low aspect ratio, i.e. ratio of beam diameter to acceleration distance required.

Unit Weight

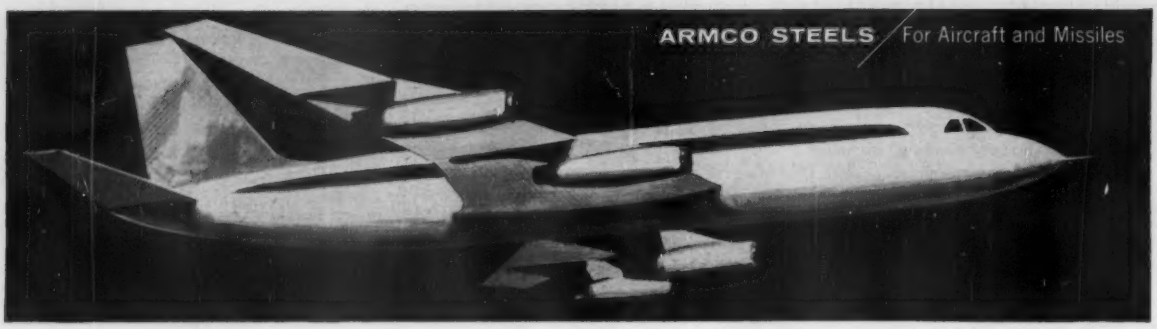
The weight of an ion or plasma propulsion unit will be small compared with the weight of the nuclear power plant needed to supply it with the required electrical power. For example, the SNAP-8 nuclear turbo-electric power generation system now under development will weigh about 2,000 lb. in the 30 kw. version, around 3,000 lb. in the 60 kw. size.

Thus the efficiency with which the



Gravity Locator Used in ICBM Tests

Instrument to measure the mass and center of gravity in three axes of the Air Force Titan and Minuteman intercontinental ballistic missile nose cones has been developed by Dynametrics Corp., Burlington, Mass. Device produces readout of weight and CG along roll, pitch and yaw axes during re-entry and is used primarily in pre-flight tests in wind tunnels. Company says the device has an over-all accuracy of 0.010 in. over an operating range of 1,800-4,500 lb. Unit is air-transportable for field testing.



Armco Precipitation-Hardening Stainless Steels

Help Assure Predictable Performance

Armco 17-4 PH / PH 15-7 Mo / 17-7 PH combine functional reliability and structural durability for severe service

For structural components or accessories that must operate under high heat and stress, designers of both military and commercial aircraft are specifying Armco's Precipitation-Hardening Stainless Steels to achieve as-designed performance.

These space-age metals are widely used because they provide—

High Strength-Weight Ratios—Minimum ultimate, tensile strengths in the heat treated conditions range from 180,000 psi for 17-7 PH to 225,000 psi for PH 15-7 Mo.

Elevated Temperature Strength—Excellent creep, stress-rupture and yield strengths up to 800-1000 F help overcome heat problems. Extensive data on properties at elevated temperatures available.

Good Corrosion Resistance—Superior to the standard hardenable stainless steels. Eliminates the cost and weight of surface protection.

Producibility—Excellent fabricating characteristics and availability in sheets, strip, foil, plates, bars, wire and forging billets simplify both design and production.

Use the multiple advantages of these high strength Armco Stainless Steels to help give your products the predictable performance demanded in today's aircraft. For the data you need on mechanical properties or fabrication, write to Armco Steel Corporation, 2239 Curtis Street, Middletown, Ohio.

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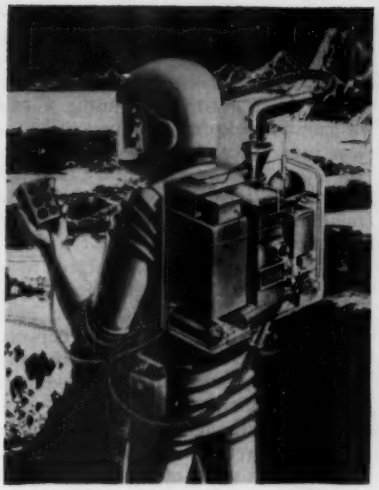


Space Oxygen Unit

Closed circuit oxygen system carried on an astronaut's back to provide breathable air has been designed by AiResearch Manufacturing Division of the Garrett Corp. Unit weighs 50 lb., stores 6 hr. oxygen supply.

propulsion unit converts electrical energy into thrust will be an important consideration. Generally, the ion engine is given at least a slight edge over the plasma engine in efficiency, although Lockheed's Kash and Starr believe there is no reason to believe that the two won't be comparable in this respect.

The ion engine requires several voltage supplies whereas the plasma engine requires only a single high-voltage supply. However, some plasma engines require a sizable number of capacitors to store up the high energy required for current discharge through the plasma.

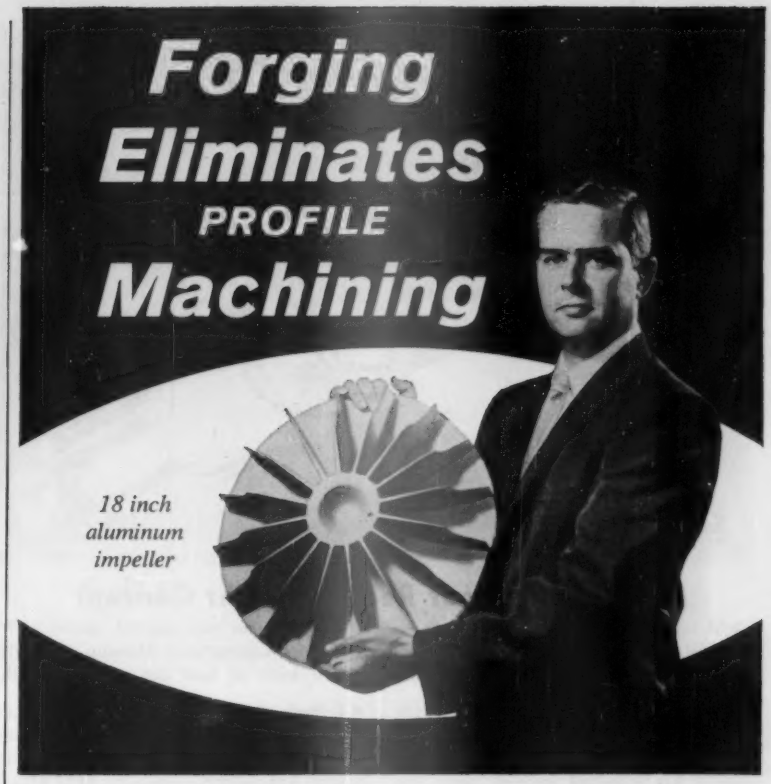
Thrust Control

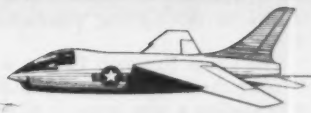
The ion engine normally is considered a continuous-operation device in which thrust level is controlled by the amount and/or rate at which vapor is fed to the ionizer. Some plasma engines are essentially continuous, and others are pulse-type propulsion units in which applied thrust is controlled by varying the firing rate.

Ability to operate reliably over extended periods of time measured in months or even years will be an important criteria for selecting an optimum electrical propulsion system. At the present stage of development it appears premature to predict whether ion or plasma engines will have a decided reliability advantage over the other.

Here are some of the electric propulsion investigations under way at Lewis Research Center, as reported by NASA's Moeckel and Rayle:

• **Electro-thermal propulsion:** NASA has launched a small arc-jet research project to investigate possibilities of ob-





This big 18" aluminum* impeller was originally *machined* from a rough forging...requiring many costly man-hours. Then Arcturus, utilizing techniques they have pioneered, developed a method for *forging* the vanes to the finished state shown above . . . saving considerably on material, eliminating all profile machining and reducing the cost of the finished part substantially. Grain flow follows the contour of the part, providing greatest possible strength.

This was no minor achievement as the impeller was an exceptionally difficult part to make by any known method. The vanes are approximately 3" high and less than 1/16" thick, yet extremely close tolerances were held.

Very likely, that machined part you are designing could be *forged* by Arcturus far more efficiently. We work in most metals and high temperature alloys. Send us your drawings and specifications today for further information.

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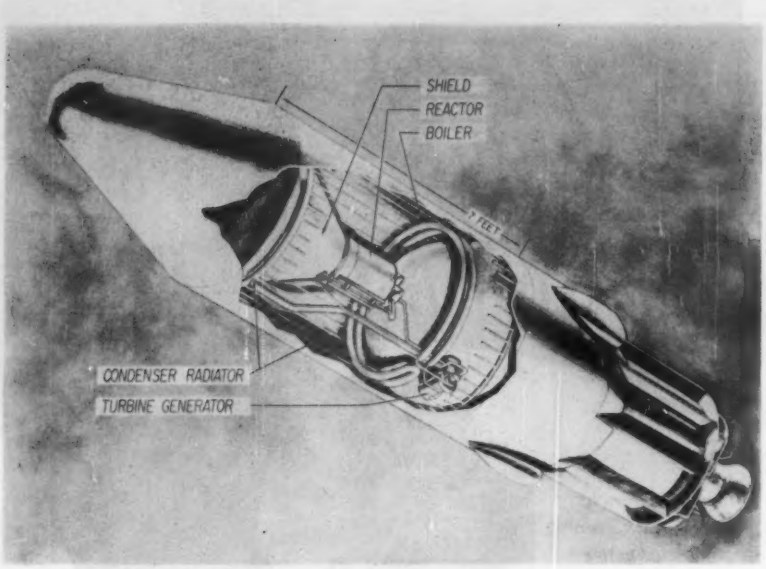


SNAP II Nuclear Reactor Flight Concept

Flight configuration of SNAP II small nuclear power system experimental reactor (AW Nov. 30, p. 37) is shown in this concept by Atomics International Division of North American Aviation, Inc. Reactor produces 50,000 watts of heat and weighs 220 lb.

taining efficient, long-duration electric arcs at the pressures and power levels suitable for space propulsion. Agency also is investigating use of radio frequency fields for heating propellant gas. Helium, used as the working fluid, is introduced into a tube which is heated by an RF coil that is fed by a 30 mc., 7 kw. power supply. Tests to date indicate that the RF energy does produce intense heating but NASA has not yet obtained quantitative data on the efficiency of energy transfer to the gas.

• **Traveling-wave accelerator:** Acceleration of plasma along a tube by means of a series of coils spaced along the tube which are excited by polyphase RF energy so as to produce a magnetic field or magnetic mirror which appears to accelerate down the tube, also is under investigation. Using a 1 kw. single-phase power supply for early tests, NASA found that velocities of 10,000 meters/sec. could be achieved. Forthcoming tests, using a three-phase 40 kw. power supply, are aimed at determining jet velocities, gross thrust and efficiency as well as nature of inefficiencies. Propellant materials to be used in experiments include lithium and nitrogen.

• **Crossed-field accelerator:** One of several possible systems for obtaining plasma acceleration through the use of crossed electric and magnetic fields which NASA is investigating employs the plasma as a conductor carrying current across a magnetic field with a resultant force being exerted on the plasma. Tests to date on a rail type accelerator indicate that velocities of about 10,000 meters/sec. are obtainable.

• **Pulsed plasma accelerators:** Another possible plasma acceleration mechanism employs the expansion of a current loop due to self-induced magnetic field which results in driving the conductor outwards.

The Lewis Research Center is investigating three types of pulse discharges:

• **Exploding a wire** across a pair of rail-type electrodes gives an initially dense plasma. Early tests show that about 10% of the wire mass is ejected at velocities of about 5,000 meters/sec.

• **Surface discharge** between two closely spaced electrodes embedded in a block of insulating material is being used to investigate current loop expansion technique. Such an arc may expand into a circular or toroidal configuration, detaching from the electrodes a mass of plasma with circulating electrical currents and corresponding magnetic fields.

• **Use of a backstrap** near the arc discharge enhances the strength of the magnetic field with propellant supplied as a molecular beam which condenses on the surface of the insulator bridging the gap between the two electrodes. Condenser discharge ionizes the propellant and intense magnetic field forces the plasma out at right angles to the gap. Very preliminary experiments indicate velocities of 20,000 to 40,000 meters/sec.

NASA scientists point out that for the surface discharge and backstrap techniques, the acceleration force diminishes rapidly as the plasma moves away from its initial position. This requires that system have a low time constant so that maximum possible energy stored in capacitors be available for speedy discharge.

Lockheed's plasma propulsion experiments were carried out using a pair of collinear electrodes connected to a low inductance, high energy capacitor to supply discharge energy. Leads between the capacitor were arranged to maintain low inductance and to orient direction of discharge forces.

With the capacitor charged to a high voltage and the region around the electrodes evacuated, discharge is initiated by introduction of plasma between electrodes. In one set of experiments, plasma was produced by exploding a fine wire mounted between the electrodes at right angles to the plane of the discharge circuit. In a second set of experiments, a discharge was produced by introducing a tiny amount of argon gas between electrodes with subsequent electrode erosion under discharge conditions producing the major portion of the plasma.

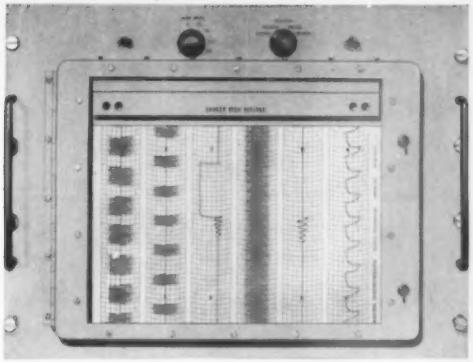
Magnetic fields produced by the large current in the discharge and the nearby circuit elements accelerates the plasma. The magnetic field of the opposing current in the lead paralleling the discharge provides the direction and principal force for accelerating the plasma.

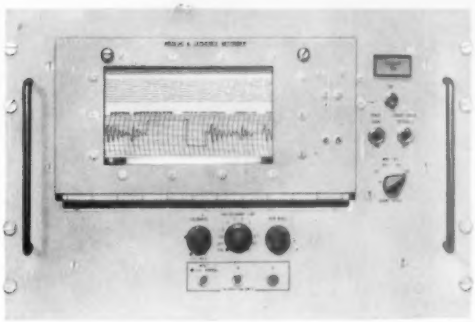
Using exploding wire to produce the plasma, Lockheed obtained maximum plasma velocities of about 80,000 meters/sec. as measured by an electronic camera. Maximum measured impulse of 1,800 dyne-seconds, equivalent to specific impulse of 2,210, was obtained with a 1-mil tungsten wire. Using electrode erosion as the plasma source, Lockheed obtained measured impulses of 640 dyne-seconds with as little as 6 micrograms of argon gas to initiate discharge and with a capacitor voltage of 30,000 v.

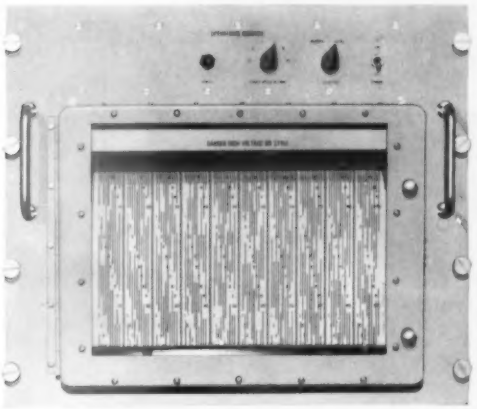
Newly applied technique for controlling and measuring amount of alkali vapor introduced into ionization chamber will make it possible to measure quantitatively the ionization efficiencies of a variety of ionizer surfaces and configurations, Samuel Naiditch, Electro-Optical Systems, Inc., told the ARS.

The new valving and metering technique makes use of the fact that glass can transport alkali ions under the influence of an electric field. If a molten salt or alkali metal is placed on one side of a glass and an electric field is applied, the alkali ions migrate through the glass to the opposite side where they are neutralized to form an alkali metal.

A preliminary analysis of the possible use of charge-exchange interaction between fast (charged) ions and neutral atoms in a gas canal at the exit of the ion accelerator to neutralize ion engine exhaust, indicates that this approach is not feasible, Naiditch reported.







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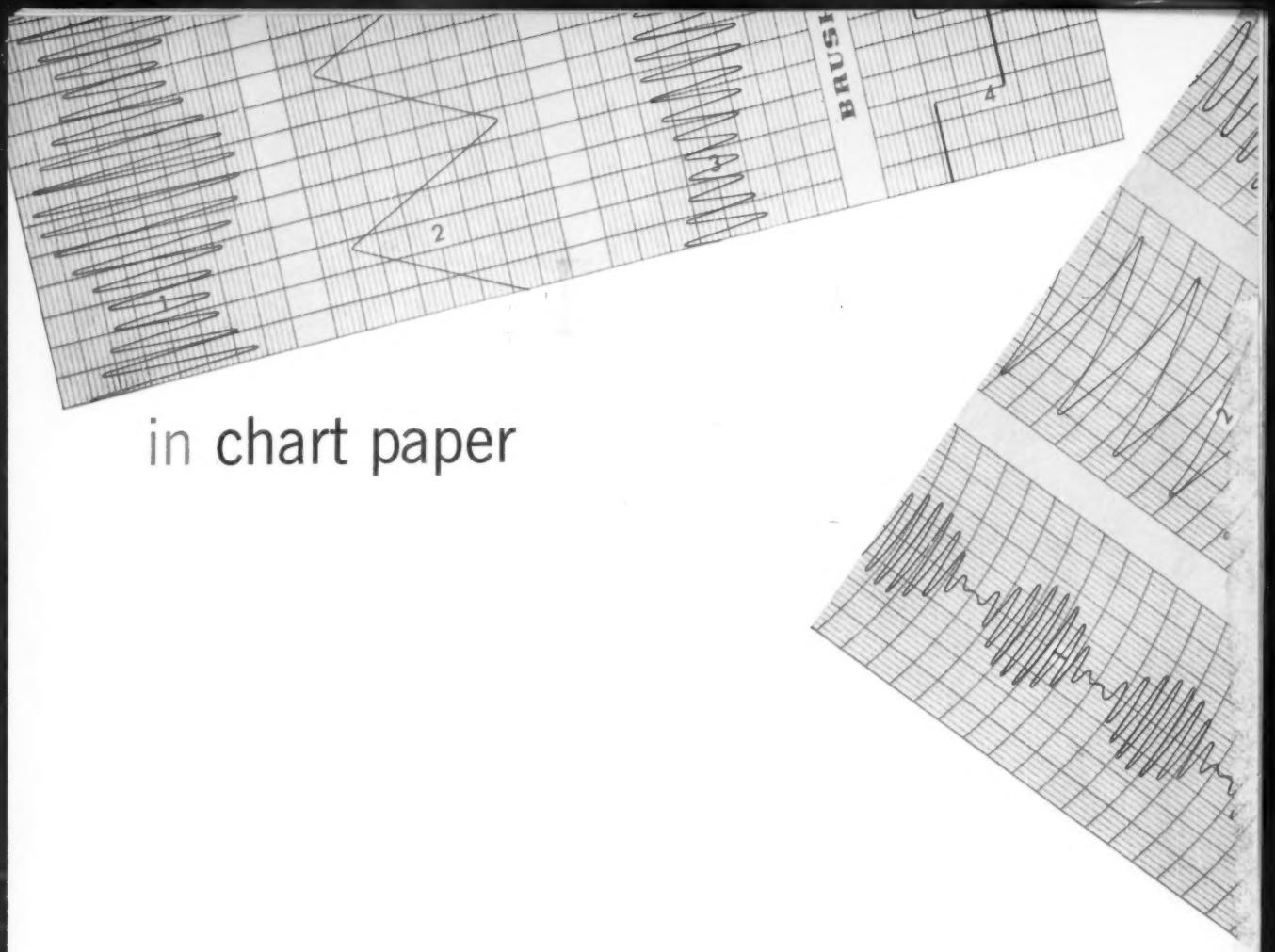

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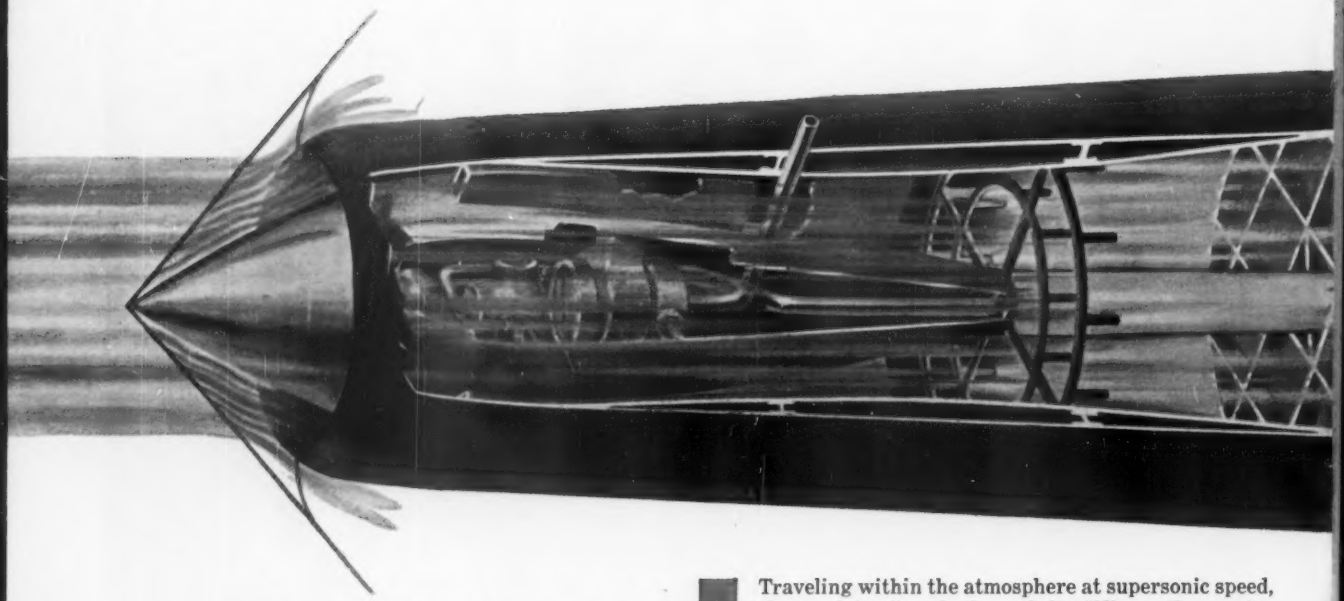
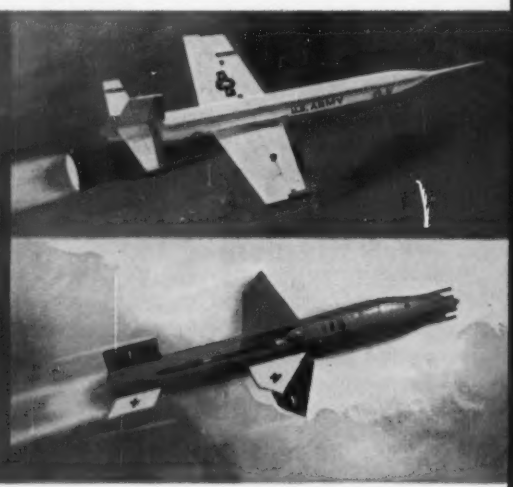
...most efficient propulsion system ever devised by man...remarkably simple, reliable and economical!



HOW THE RAMJET WORKS: Traveling within the atmosphere at supersonic speed, the ramjet gulps air through its diffuser (in grey)—compressing it by the "ramming" action caused by the engine's high forward speed.

TODAY RAMJETS POWER:

The USAF-BOEING BOMARC interceptor missile, America's first line defense missile, is Marquardt-ramjet-powered to reach out 400 miles—attacking oncoming enemies at almost three times the speed of sound.



The ARMY-LOCKHEED KINGFISHER supersonic target drone (top) uses a single Marquardt ramjet to fly missions at almost four times the speed of sound.

The NAVY-BENDIX TALOS surface-to-air missile is ramjet-powered and shipboard-launched to defend the surface fleet against attacking enemy aircraft.

TOMORROW

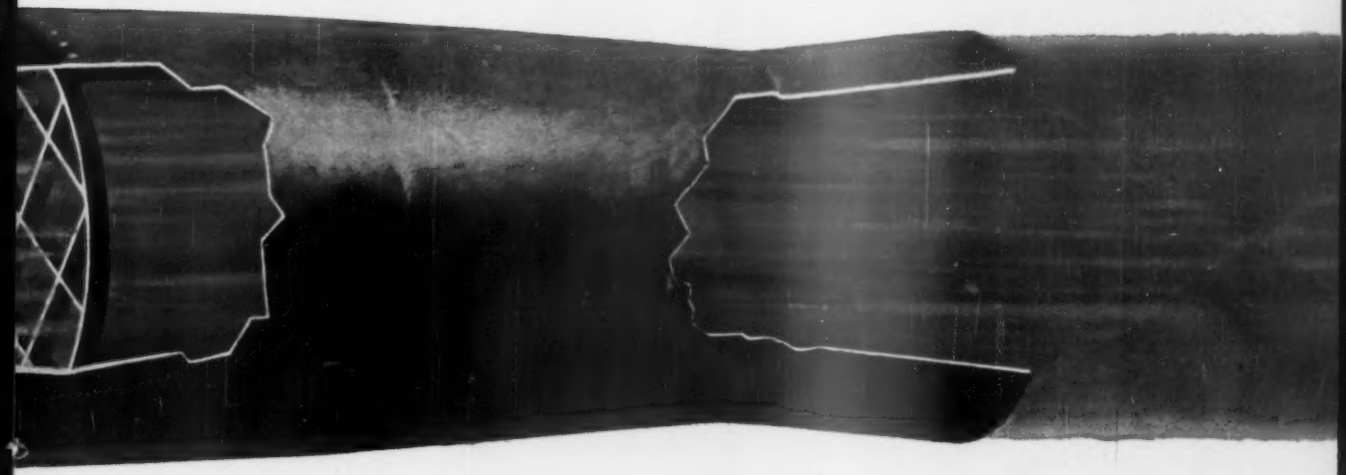
INTERPLANETARY VEHICLES. America's first interplanetary explorers may be boosted into orbit via Marquardt Hyperjet. Biggest breakthrough in the art of rocketry since its conception, it combines both rocket and ramjet advantages.

The ramjet family of engines for aircraft, missiles and space vehicles is unique because of its simplicity of operation. Without moving parts in the basic engine system, the ramjet develops compression ratios of more than 100 to 1 at 2600 miles an hour—yet can use kerosene as fuel. By comparison, your piston-engined car needs "super-premium" gasoline for compression ratios of only 10 to 1.

Now compare the ramjet with the rocket engine. The ramjet can get along on 1/10 the propellant consumption of a rocket. That's because rocket engines must carry along their own oxidizer, while the ramjet scoops its oxidizer from the atmosphere.

The ramjet delivers speed, too. A Marquardt ramjet has already flown faster than Mach 4 (that's four times the speed of sound, or about 2,600 miles an hour)—and ramjet speeds of over 13,000 miles an hour are feasible. By contrast, turbojet engines—the powerplant powering today's 600 mph jetliners—are limited to speeds in the Mach 3 range. By eliminating the moving parts turbojets need to develop compression, the ramjet delivers greater speeds and reliability—costs less to make, operate and maintain.

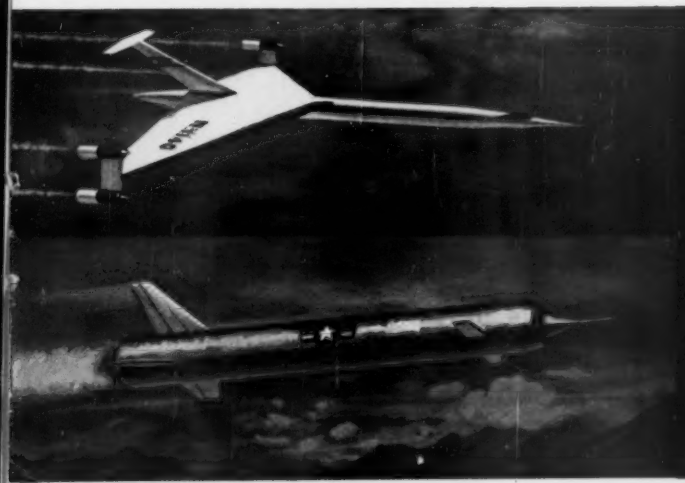
This speed and reliability, along with its efficiency, is why today's ramjets are making significant contributions to America's defense effort—powering two front-line defense missiles and a sophisticated target drone. Look for tomorrow's ramjets to accomplish peaceful and military missions as yet unconceived—powering vehicles still to be invented.



Fuel is injected automatically and mixes with the air as it speeds toward the flameholder. The mixture is burned, and this combustion expands and accelerates the burning gases.

Thrust comes from the rapid acceleration of these gases through the engine. This action pushes the entire ramjet—and the vehicle it is carrying—forward at ever-faster speeds.

RAMJETS WILL POWER:



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THE Marquardt CORPORATION

Founded in 1944 to pioneer in developing the ramjet as a basic powerplant, Marquardt today employs more than 5,000—of whom more than ⅓ are scientists, engineers and skilled technicians—in the fields of advanced space research, power systems, controls, nucleonics, simulator-training, research rocketry, weapon systems support and manufacturing.

For a reprint of this advertisement you are invited to write: Roy E. Marquardt, President, The Marquardt Corporation. Corporate offices: Van Nuys, California.

AIRDROP TO THE "LOST BATTALION"

LEACH HERITAGE OF THE AIR—7

Banking gently, the big biplane slipped down out of the low clouds, braved a sudden burst of enemy gunfire, and rushed over the hilly, heavily wooded terrain. Glancing back at his observer, the pilot nodded to the ground. The observer began dropping packages over the side. Somewhere below, hidden by the dense foliage and undergrowth of the Argonne Forest, and surrounded on all sides by Germans, lay the injured and dying men of America's "Lost Battalion."

It was October 6, 1918, the date of the first aerial resupply drop in combat history.

With its pass completed, the two-seater D.H.-4 headed back for Remicourt, home base of the A.E.F.'s 50th Aero Squadron. At the controls was Lt. Harold E. Goettler, a flight commander from Chicago. His observer was Lt. Erwin R. Bleckley of Wichita. Later in the day, Goettler and Bleckley took off on their second mission. They never came back. Ground fire sent them crashing to their deaths near Binarville, France.

The story of the "Lost Battalion" is today more legend than fact. Actually, the men were never lost. A battalion of the 77th "Statue of Liberty" Division and parts of a machine gun battalion were cut off after a rapid advance beyond the front lines during the Meuse-Argonne offensive.

By daybreak on October 3, the men were encircled by Germans and exposed to heavy shelling and machine gun fire. For the next

four days they were ravaged by hunger, thirst and death and subjected to continuous enemy attack, including a barrage from their own artillery.

On October 6, the 50th Aero Squadron, which had flown its first mission only three weeks before, was called in to airdrop supplies. The squadron flew 15 missions the first day. Coordinates flown out from the "Lost Battalion" by carrier pigeons, giving the Battalion's location, proved in slight but serious error and the trapped men received only a fraction of the supplies. Finally, however, an airdrop team spotted the correct position and the remaining men were rescued on October 7.

The planes used in history's first recorded airdrop were D.H.-4's designed by Geoffrey de Havilland, the famous British designer. In the final year of the war, 4,700 of the big British ships were built under license in the United States. Rugged, fast and reliable, the D.H.-4 was at some point in its career outfitted for every conceivable type of duty. In its original production form the D.H.-4 was powered by a 240-hp. B.H.P. engine to a top speed of 120 mph. The somewhat heavier American version, powered by a 400-hp. Liberty engine, had a top speed of 128 mph.

Because its main fuel tank was located between the pilot and the observer — directly in the line of enemy fire — the D.H.-4 was labeled the "Flaming Coffin," but it was no more vulnerable in this fashion than other aircraft. Its armament consisted of two synchronized forward firing Marlin machine guns and two swivel mounted Lewis machine guns. The D.H.-4 was still in service in 1922 when Harold Goettler and Erwin Bleckley were posthumously awarded Congressional Medals of Honor. D.H.-4's similar to the ship they flew to immortality continued in U.S. military and government service for almost another decade.

HERITAGE OF THE AIR

One of the most inspiring chapters in the history of technical evolution is the story of the men and flying machines of World War I. It is the highly personalized story of brave men — and the wood, wire, linen, and rudimentary technologies that converted manpower to airpower. Today, Leach Corporation celebrates its 40th year in electronics with the presentation of this Heritage of the Air series.

Leach thanks Col. D. P. Morse, Jr. (Ret.), Commanding Officer of the 50th Aero Squadron during the above action, for his help in preparing this account.

Technical Director for Heritage of the Air is Major Kimbrough S. Brown, USAF.

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A HERITAGE IN ELECTRONICS

Val Leach, founder of Leach Corporation, wrote the above advertisement 27 years ago. In it Mr. Leach laid down a business philosophy that is as valid today as it was in 1933. He knew there would be no room for "yesterday's heroes" among the companies supplying the vital, growing electronics industry. He knew that success would be in direct ratio to uncompromising product reliability. And he also knew that technological progress could only be based on the solving of tomorrow's problems.

This year Leach Corporation celebrates its 40th anniversary in electronics with a reaffirmation of Val Leach's time honored principles:

Solving problems is the core of the Leach philosophy of doing business. Leach will continue to base its success on anticipating customer needs and meeting them with advancements tailored to specific requirements.

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Pyrographite May Cut Nose Cone Heat

Waltham, Mass.—New form of graphite, with controlled crystal orientation that gives it novel thermal, electrical and other properties, may enable ballistic missile nose cones and rocket engines to operate at higher temperatures. (AW Nov. 16, p. 39).

Oriented graphite has been produced in small quantities in research laboratories for more than 50 years, but can be produced in commercial quantities by a new process developed by Raytheon Co. with the partial sponsorship of the Navy's Special Projects Office.

A pilot production facility has been constructed by Raytheon in Lawrence, Mass., which will be capable of accepting forms or mandrels in shapes measuring up to 12 in., and is planning the establishment of a full scale facility capable of handling larger shapes and producing greater quantities of the material.

Problems still remain in adapting the process to really large scale production, but these are under active investigation by the company.

Called "Pyrographite" by Raytheon, the material vaporizes at the same temperature as ordinary graphite (approximately 6,350F), which has the highest temperature limit of any elemental material. Thermal and electrical conductivity of Pyrographite, moreover, is strongly anisotropic—that is, it is higher by several orders of magnitude in a plane parallel to the surface than at right angles to it. Raytheon claims, also, that the material has the properties of high density and impermeability to gases.

In the new process, molecules of carbon or graphite are obtained from a carboniferous gas and deposited on a substrate (base), with controlled crystal orientation. Pieces formed entirely of Pyrographite can be produced by deposition on the inner surface of a graphite mandrel, which is after cracked away from the workpiece.

In the plane parallel to its surface, Pyrographite has a higher heat conductivity than copper, while at right angles its conductivity is lower than normal graphite and, also, lower than in some low-conductivity ceramics. Ceramic materials commonly increase in thermal conductivity above some characteristic temperature because of the contribution of radiation to thermal conductivity. Raytheon says that no such contribution has been shown to date for graphites or Pyrographite, which makes the thermal insulating properties of Pyrographite compare even more favorably with those of conventional solid thermal insulators. This conclusion, the company says, has been verified by very high temperature arc plasma and rocket engine tests.

Other properties are:

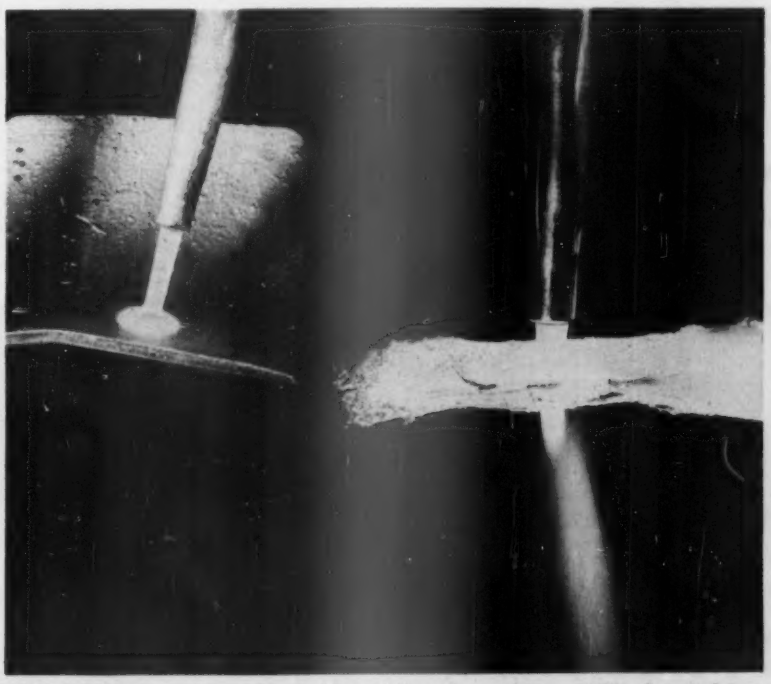
• **Electrical.** Results of initial tests indicate electrical conductivity properties of the new material are similar to its thermal characteristics. Resistivity at right angles to the surface increases with higher preparation temperature, while it decreases in the direction parallel to the surface. The degree of anisotropy is of the order of 1,000 to 1 for material prepared at 2,000C. Resistivity along the layer planes is considerably less than for normal graphite, which is considered a good conductor; across the layers it is far greater than for graphite.

• **Density.** A significant property of the material as compared with normal graphite is its high density. The theoretical density of normal graphite is 2.26 grams per cubic centimeter: ordinary graphites range from 1.6 to 1.7, while densified graphites run from 1.7 to 2.0. Pyrographite has been prepared with densities as high as 2.22. Density increases with the temperature of preparation because of a higher degree of crystallite orientation at higher temperature.

• **Mechanical properties.** Strength-to-weight ratio of the material is higher than for Series 310 stainless steel at low temperatures while above 2,000C, where normal graphite has one of the highest strength-to-weight ratios known, it has a ratio five times as great. Tests conducted with Pyrographite and normal graphite in highly erosive atmospheres such as those produced by a high velocity, high temperature reducing stream of solids and gases resulted in slight erosion of the oriented graphite, compared with almost complete breakdown of the normal graphite. This property is attributed to the oriented crystal lattice which presents low-reactivity basal planes to the gas stream.

• **Impermeability.** A characteristic of interest for applications to nuclear reactors is the material's impermeability to gases. Using a standard mass spectrometer leak detector, no permeation by helium has been detected, even after heating to 2,500C and re-cooling in films as thin as one or two mils.

Graphite, due to its high density and low atomic number, is frequently used as a moderator in nuclear reactors. Oriented graphite is denser than normal graphite, so it possesses the advantage of presenting more atoms per unit volume for moderating neutrons. Because the material is extremely pure as prepared, Raytheon says, it requires



PYROGRAPHITE, an elemental material consisting of a graphite crystallite deposited in a highly oriented manner, resists butane torch flame (left). The same blast at right burns a hole through a sheet of asbestos. The material can be deposited on a substrate (base) or on a breakaway graphite mandrel.

SMALL APPETITE NOISE SOURCES

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Until recently signal simulators for monitoring radar receivers or microwave relays were of two types. One was a big and heavy ampere eater with cumbersome auxiliary equipment; and the other was a sensitive though delicate instrument suitable only for the laboratory.

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The Litton family of miniature gas noise sources, like all Electron Tube Division products, was designed to solve specific end item functions. We have found that this philosophy contributes to consistent reliability: tubes do their jobs more efficiently, for longer periods of time, and at lower overall cost to the buyer. Other advantages also result. For example, these noise sources require *no* ageing-in and the L-2000 is replaceable in the field without changing the mount.

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CAPABILITY THAT CAN CHANGE YOUR PLANNING

no further purification for reactor purposes and eliminates the problem of potential poisoning from impurities found in ordinary graphite.

Because it is impervious to gases, the company points out, it can be used as a coating for fuel elements to keep gaseous fission poisons out of the coolant stream, while its strength at high temperatures will enable it to contain appreciable pressures of fission products.

Production Process

The process of producing Pyrographite on a commercial scale that Raytheon is developing has reached the point where it is now possible to reproduce shapes of various dimensions with wall thicknesses up to one-half inch. This can be on a substrate or a commercial graphite form. The process is based on high temperature pyrolysis of carbon-containing vapors.

The development and pilot production work to date has been with resistance or induction-heated furnaces capable only of preparing samples for property measurement and small commercial pieces. Because the degree of orientation of the material is highly dependent on the temperature during deposition—over a temperature range extending above 2,000C—process control problems increase rapidly with increasing size of production pieces.

The most obvious structural difference between Pyrographite and normal graphite, the degree of orientation of the graphite crystallites, lies in the stacking of the basal planes.

In the crystallite of normal graphite, each layer has a well-defined position relative to the neighboring layers, where in Pyrographite the stacking of the layers occurs in a random fashion. The randomness in layer stacking destroys the periodic repetition of atom positions at right angles to the basal plane so that the structure can no longer be described as a repetition of unit cells. It is this difference in structure that gives Pyrographite its difference in mechanical, thermal and electrical properties.

Rocketdyne Develops Portable Solid Plant

McGregor, Tex.—Continuous processing pilot plant for mixing solid propellants is going into operation here at the solid rocket plant of Rocketdyne Division of North American Aviation, Inc.

Quickmix pilot plant was trucked here from California on a 30 ft. trailer, and this mobility demonstrates the potential field loading capability of the system. Plant has a minimum mixing capacity of 500 lb. per hour, and a maximum of 5,000 lb.

Safety stems basically from the fact that only a small amount of the propellant material is in the mixer at one time, while the present batch-mixing methods require relatively large amounts of propellant materials to be combined in a single batch. Low cost and versatility are also cited as advantages for the new process.

Rocketdyne has used its new Quickmix system with several solid propellant combinations and is continuing to apply the process to a variety of propellant combinations under contract to the Manufacturing Methods Division, Aeronautical Systems Center of Air Materiel Command.

Scientists to Discuss Space Trajectories

First symposium on space trajectory determination, covering fundamental astronautical constants and units, military space, astromechanics, trajectory computation and optimization, space maneuvers and ascent and re-entry, will be held Dec. 14-15 at the Langford Hotel, Orlando, Fla. Radiation, Inc., is host.

Speakers include Krafft A. Ehricke of Convair Division of General Dynamics Corp., and Dr. C. A. Whitney, Smithsonian Astrophysical Observatory.

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Paint Gives Missiles Thermal Protection

By Michael Yaffee

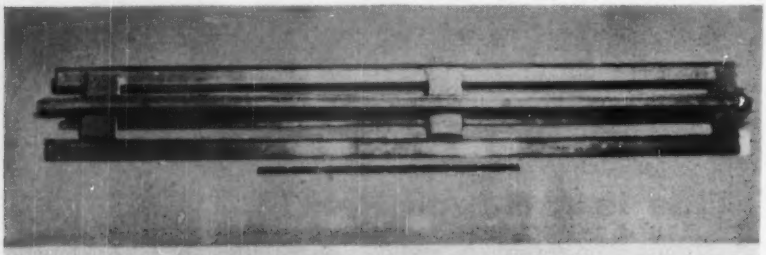
St. Louis, Mo.—Thermal protection that can be painted on missiles to the exact temperatures required is now being offered to engineers by Emerson Electric Manufacturing Co.

The protection, which comes in the form of a family of tailor-made subliming paints, is offered as a low-cost, lightweight means of controlling the high temperatures induced in missiles and space vehicles by aerodynamic friction, solar heating and rocket exhaust gases.

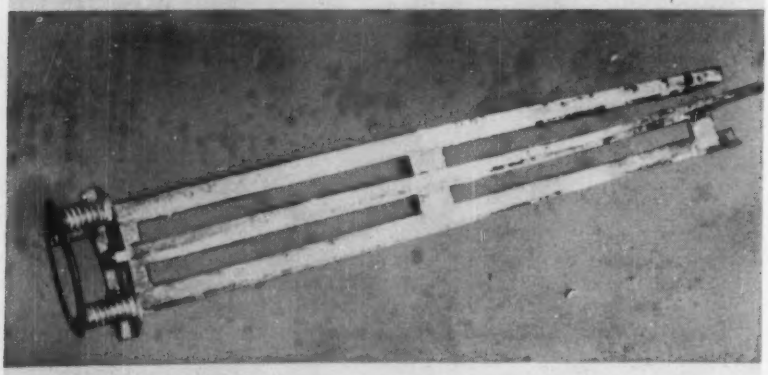
To date the material has been used on the nozzle of the Honest John rocket and is under evaluation as a coating for the resonance suppressor in an advanced version of this rocket now under development. The material is also being evaluated for the Little Joe capsule, the Project Mercury capsule and, reportedly, for all three stages of the Minuteman airframe.

Pilotless Aircraft Research Division of National Aeronautics and Space Administration has run a series of tests, including heating and erosion, on small coated samples and reports that the results are sufficiently encouraging to merit further evaluation of the material for possible use on the glass fabric polyester laminate body of its Little Joe capsule. First coated Little Joe capsule is scheduled for a flight test the first week in December. PARD has also coated live solid propellant rocket engines with the material and considers the coating definitely worthy of consideration for advanced structures such as Dyna-Soar.

The subliming paints, developed by Emerson's Rubin Feldman, are called Thermo-Lag. At present, there are four formulations available which sublimate at 230F, 450F and 600F. Under development are three other Thermo-Lag formulations which will sublime at 850F, 1,100F and 1,450F. Theoretically, says Feldman, there is no limit to the sublimation temperatures that can be built into the basic Thermo-Lag formulation through the use of temperature elevating or depressing agents.



RESONANCE SUPPRESSOR BEFORE FIRING
MATERIAL: ALUMINUM
THERMAL PROTECTION: "THERMO-LAG"-.015"



RESONANCE SUPPRESSOR AFTER FIRING
MATERIAL: ALUMINUM
THERMAL PROTECTION: "THERMO-LAG"

SOLID PROPELLANT rocket resonance suppressor, made of aluminum and coated with Thermo-Lag, is shown here before and after 1.6-sec. exposure to 4,500F at 1,000 psi.

Material's Composition

Essentially, Thermo-Lag consists of inorganic salts in organic and inorganic binders. It is mixed and applied like a paint by either brushing, spraying or dipping. Emerson is currently working on a Thermo-Lag formulation that will have structural strength as well (by using it as strata in a laminated structure or as a filler in porous metals) but this is in a very early stage of development. One of the principal attractions of the Thermo-Lag formulations is that the material can be cured at approximately room temperature, around 80F. This means that it can be used to coat live solid propellant rocket engines.

The fact that the material can be applied like a paint is also important. It means the material can be used on odd-shaped and otherwise difficult-to-coat structures. It was one of the main considerations in NASA's interest in the material for the Little Joe capsule.

How It Works

In a somewhat simplified manner, this is how the 230F Thermo-Lag formulation, works: As heat is generated, it is absorbed by the Thermo-Lag coating until the coating reaches its sublimation temperature, in this case, 230F. The amount of heat absorbed will depend, of course, upon the amount of coating. Roughly, it will take 47 Btu. to raise the temperature of one pound of 230F Thermo-Lag 1F.

When the temperature reaches 230F, the Thermo-Lag sublimes. In going from a solid to a vapor state, each pound of the coating absorbs another 700-800 Btu. Then the vaporized coating has to work its way through the interface to the boundary layer and this takes up more Btu. The vaporized coating thickens the boundary layer, serving as a gas shield to further protect the underlying structure from heat. At extremely high temperatures, the gaseous Thermo-Lag will ionize or decompose and therein absorb more heat.

Over-all, one pound of Thermo-Lag will absorb about 5,000 Btu. from the first heat input to final decomposition. But this figure, says Feldman, will increase with the rate of heat input. The more heat that is applied, the greater

the amount of gases that will form. (Rate of heat transfer to the material and the thermal conductivity of the material will determine the thickness of the coating that will sublime.) The greater the amount of gases formed the greater the energy required for them to diffuse into the boundary layer and the thicker the boundary layer becomes. Consequently, says Feldman, the overall figure could become 15,000-20,000 Btu. absorbed per pound of Thermo-Lag at a heat input or ablation rate of 2,000-2,500 Btu./ft²/sec. Until all the Thermo-Lag coating is gone, the underlying structure remains at or close to the sublimation temperature of the specific formulation chosen. For the Little Joe capsule, PARD, knowing that 300F was the top temperature the plastic body could take, chose the 230F Thermo-Lag formulation for this project.

For the Dyna-Soar, it is expected that NASA will need a material that will sublime at 1,700F, and Emerson is ready to start work on a Thermo-Lag formulation to meet this high temperature requirement.

Determining Thickness

Once the top permissible temperature for the structure is determined and the right Thermo-Lag formulation selected, the next step is to determine the thickness of the coating required. From the trajectory profile of the mission the vehicle will have to perform, heat input rates can be determined for each interval of the flight. In one five-second segment of the trajectory, for example, heat input to the vehicle may be 100 Btu./ft²sec. or a total of 500 Btu./ft².

From the chart of the selected Thermo-Lag formulation, say the 230F coating, it is learned that the material can absorb 7,000 Btu./lb. at the rate of 100 Btu./ft² sec. Dividing 500 Btu./ft² by 7,000 Btu./lb. gives .07 lb./ft² for this segment of the trajectory. Then, dividing .07 lb./ft² by 70 lb./ft³, the density of the Thermo-Lag formulation, gives the required thickness of .001 ft. or .012 in. Adding the results from each segment of the trajectory will then provide the total thickness of the specific Thermo-Lag formulation required.

Weight Savings

By thus tailoring a protective coating to a specific application, says Feldman, it is possible to realize important weight savings. In addition, the material has high thermal shock resistance; in one demonstration, it went from ambient temperature to 4,500F in 15 milliseconds successfully. In the case of the Honest John resonance suppressor which fits inside the solid propellant grain and is currently a coated steel structure, says Feldman, Thermo-Lag makes possible the substitution of

WORKER SPRAYS outside surface of Honest John rocket nozzle with Thermo-Lag (above). Coating is dryed and cured (below) with relatively simple set-up of 375-watt infrared lamps arranged in ring around throat section.

THERMO-LAG jacket on Honest John nozzle remains intact after impact of the rocket. Jacket is scored to provide greater surface area.

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Redstone's Mercury Role

Washington—Tentative schedule for use of the Redstone missile in National Aeronautics and Space Administration's manned capsule project now calls for six shots without animal life, one carrying a chimpanzee in the capsule and the eighth and last carrying one of the seven Mercury space pilots. Firings probably will not begin before early spring. A second plan being discussed is to fire three capsules, empty except for instrumentation; place a chimpanzee in the fourth; and put space pilots in the last four capsule shots if earlier launches are sufficiently satisfactory.

an aluminum structure, with a resultant weight reduction of 60-70%.

Used on the outside of the Honest John nozzle, Thermo-Lag serves the same function as a water jacket (not as an ablative coating) without the weight or complexity, by reducing the nozzle's metal temperature. In this application, the Thermo-Lag jacket is scored to provide additional surface area and passageway for the cooling gases and to better enable the jacket to expand with the metal.

Radiant Emission

In applications where radiant emission becomes a significant factor, it is also possible to vary the surface thermal emissivity of the Thermo-Lag coatings by the proper choice of formulations without basically altering any of the other physical or thermodynamic properties of the material.

But one of the most important attractions of Thermo-Lag, says Feldman, is the fact that sublimation temperature is not a function of the rate of heat input.

This characteristic, he believes, makes Thermo-Lag superior to ablative systems (based on materials like Teflon and nylon) currently being used on some missile nose cones.

Not All Enthusiastic

Many potential users of Thermo-Lag, however, are not quite so enthusiastic as Feldman. The material is still a comparatively new development and as such admittedly has not yet reached its full potential nor resolved all its drawbacks. For one thing, Thermo-Lag is hygroscopic and, in the event of a rain just before launching, could pick up enough moisture to interfere with the flight of a vehicle such as the Little Joe and the functioning of its electronic equipment. NASA has made some effort to develop a vinyl or rubberized preflight coating that could be peeled away at launch and leave the Thermo-Lag clean and dry.

But even without such a coating, NASA's PARD group doesn't consider this drawback serious enough to prevent the use of Thermo-Lag.

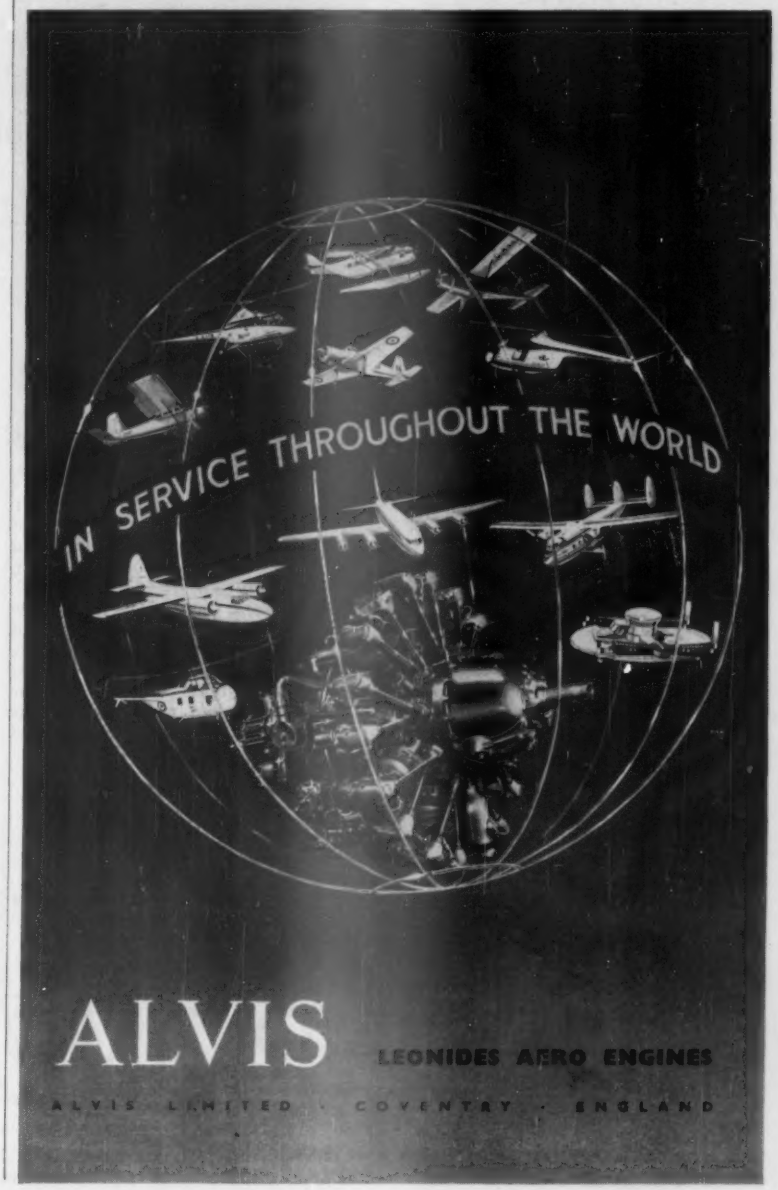
McDonnell Aircraft engineers, who are evaluating Thermo-Lag for the Project Mercury capsule, feel that while everything Emerson says about the material may be true, the big question that still has to be answered is whether it will do the specific job required on the Mercury capsule.

At this point, Thermo-Lag is simply one of many heat protection systems McDonnell is currently investigating for the Mercury project, says one engineer, not the answer to a maiden's—or spaceman's—prayer.

Hawker-Siddeley, Nord Enter Into Missile Pact

Paris—Nord Aviation and the Hawker-Siddeley Group intend to exploit jointly the Mach 2 target missile, the CT-41, recently developed by the French manufacturer. The CT-41 is powered by two ramjets mounted on the wingtips of the target missile.

Under the Franco-British agreement, Hawker will undertake to build and maintain the missile and presumably will handle sales efforts throughout the British commonwoath. Nord's earlier target missile, the CT-20, achieved considerable success with NATO.



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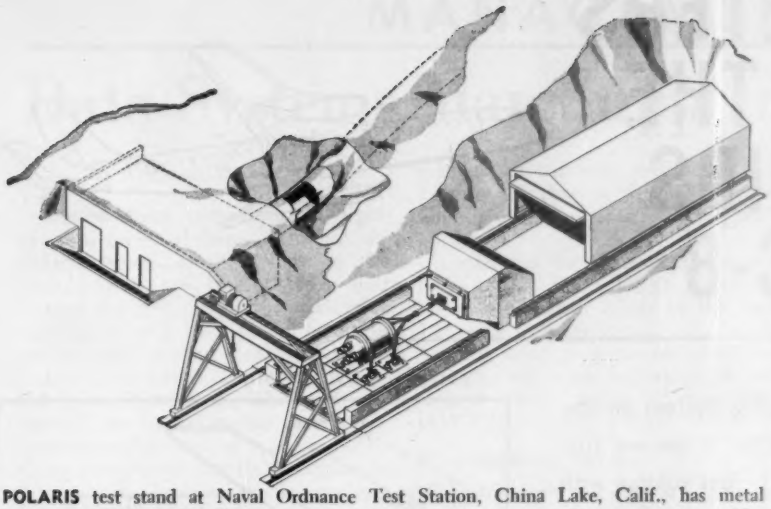

POLARIS test stand at Naval Ordnance Test Station, China Lake, Calif., has metal housing (right) which rolls back over rocket and instruments. Instrumentation cables feed into building at left, through tunnel up hill to data reduction and control center.

Facility Tests Solid Propellants

China Lake, Calif.—New rocket engine static test complex capable of handling engines of up to 1-million-lb. nominal thrust has been completed at Naval Ordnance Test Station here.

Aimed primarily at solid propellant engines, the facility seeks to achieve test accuracy which is 400% higher than previous standards. Installation cost $650,000 and is ready for firings now and will start a full scale Polaris fleet ballistic missile engine test program late this year.

Data acquisition, recording and assessment equipment is such that the complex will be able to analyze propulsion characteristics to within 0.25% error, as compared with the previous standard of 1%.

Design is such that the stand will accommodate nominal running thrusts of 1 million lb., while peak thrusts of up to 10 million lb. will be handled. Facility was built for Special Projects Office of Navy Bureau of Ordnance.

Test bay is 35 ft. long, 30 ft. wide and can accommodate engines larger than 6 ft. in diameter, 30 ft. long and weighing up to 100,000 lb. Firing control and instrumentation blockhouse is located a quarter-mile away, buried in a hillside, 37 ft. higher than the test stand.

Engines are first to be brought to a conditioning building where atmospheric conditions of temperature, pressure, humidity are made to order to match the expected environment of Polaris.

Structure also serves as a stowage magazine and can maintain constant temperature within plus or minus 3F in the range from 70F to 110F all year.

Engine's nose is pushed up against instrumentation which is backed by 12 in. of steel armor plate mounted on a concrete block 13 ft. thick and 13 ft. high.

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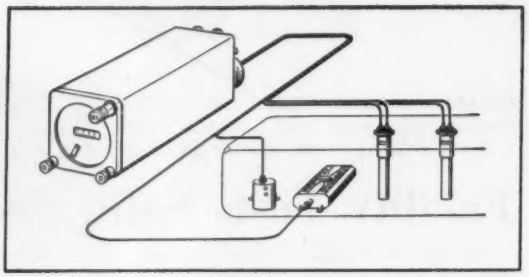
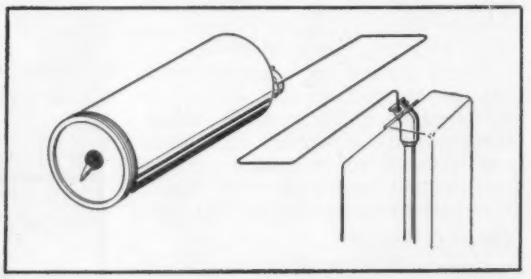
*Liquidometer trademark for its electric hydrometer.



ENGINE OIL Liquidometer Oil Gages for the DC-8 are capacitor type gages, each comprising an indicator-power unit and a capacitor type tank unit. The system is fully transistorized. Bridge and amplifier circuitry is housed within the 2-inch diameter indicator case.



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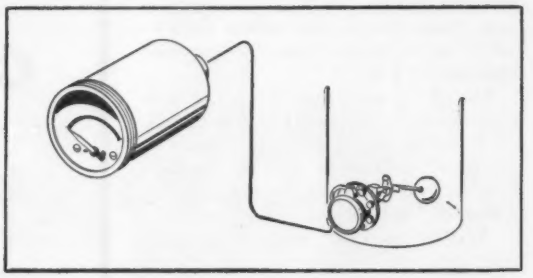

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Data Systems May Supplement Weapons

By William H. Gregory

Boston—Some companies are beginning to orient themselves toward defense business in the 1960s on the premise that a new kind of system built around the gathering and processing of intelligence will be a major factor in maintaining national security.

Itek Corp. is one. Another is Thompson Ramo Wooldridge, which has just opened an Intellectronics Laboratory specializing in this and allied fields. Companies which already are heavily or primarily involved in the data processing field—IBM, General Electric and others—could also be expected to play major roles if such a trend develops.

General Electric Co. has more recently established an Information System Section within its Defense Systems Department to design and develop complex man-machine systems involving computer, display and data storage and retrieval equipment as well as related non-hardware techniques. Dr. Lindon E. Saline of General Electric's Computer Department was named manager.

Certain of the L-series communications systems which USAF is developing may be initial efforts in this area. The 466L weather system with Bendix Aviation Corp. as prime contractor, for example, offers an indication of how such a system might be constructed (AW Oct. 6, 1958, p. 80).

Disarmament Factor

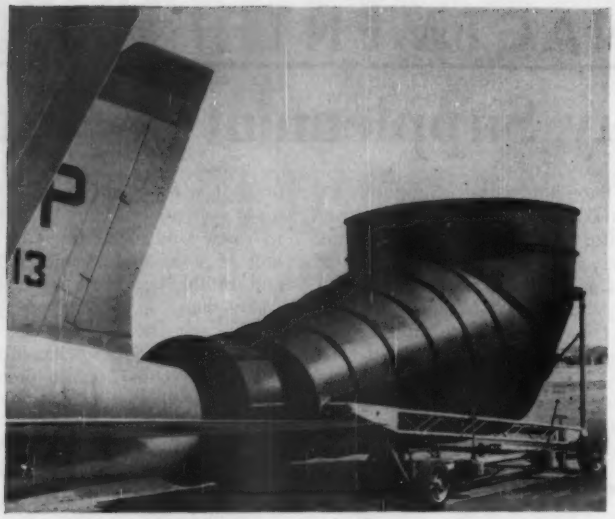
Disarmament may be a key factor in such a prospect. Itek's President Richard S. Leghorn, who has just been named deputy for technical affairs on the President's Joint Committee for Disarmament Study headed by Charles A. Coolidge, feels his company will be on the right side of the curve if disarmament does come. The committee's report is due by year end.

If disarmament does come, Leghorn feels, it will not mean the end of defense systems but rather the transition to a new kind of system. The transition will be a long slow one, he believes, and in the beginning would be more costly than current weapon systems. A system such as Leghorn has in mind might comprise these elements:

- **Space systems** on the order of the Samos satellite reconnaissance system now under development.
- **Aerial inspection,** how much depending on the degree of U.S.-Soviet agreement.
- **Ground control** inspection parties at air fields, transportation centers, etc.
- **Peripheral inspection** through use of long-range radar as in the BMEWS system, air sampling and possibly other types. The FPS-17 radar in Turkey and the Aleutians is another example of current types in use.
- **Data processing** systems not only to handle information from the previous sources but also to search open techni-

Sikorsky S-60 Crane Airlifts S-58

One of 16 Sikorsky S-58 Army helicopters is shown being airlifted by Sikorsky's S-60 flying crane during a shift of overhaul and repair facilities. The S-58s, which weigh four tons each, were carried five miles from the Stratford, Conn., Municipal Airport to Sikorsky's plant in Bridgeport. Job was completed in several flying hours; City of Bridgeport is in background.



Maxim JEM-8 Silencer on run-up duty on F8U.

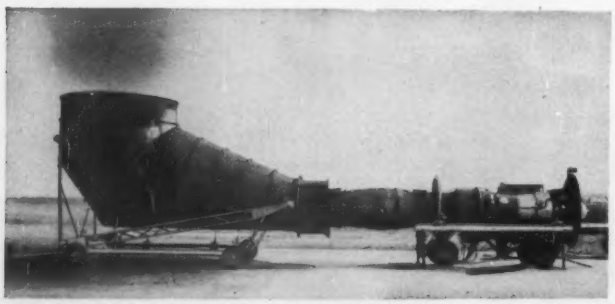
MAXIM CUTS NAVY JET NOISE 25-30 DB

Thoroughly field tested by an independent acoustical engineering firm . . . requiring no water even when afterburners are used . . . the Maxim JEM-8 Mobile Exhaust Sound Suppressor reduces jet exhaust noise by 25 to 30 dbs.

Built for high temperatures, the JEM-8 is a portable, all-metal spoiler type unit with a maximum weight of 10,000 lbs. including undercarriage. Engineered for all present types of jet aircraft, it is available with adapters for various airframe configurations.

Shown here in use at a naval air station, the JEM-8 will shortly be on duty at many other Naval and Marine Corps air stations. A commercial jet version, the JEC-8, is available for pod hung engines.

For noise suppression, consult Maxim — for it is here that Silence Is A Science.



JEM-8 with undercarriage raised for test stand.

SEND FOR FOLDER "JET ENGINE SILENCING"

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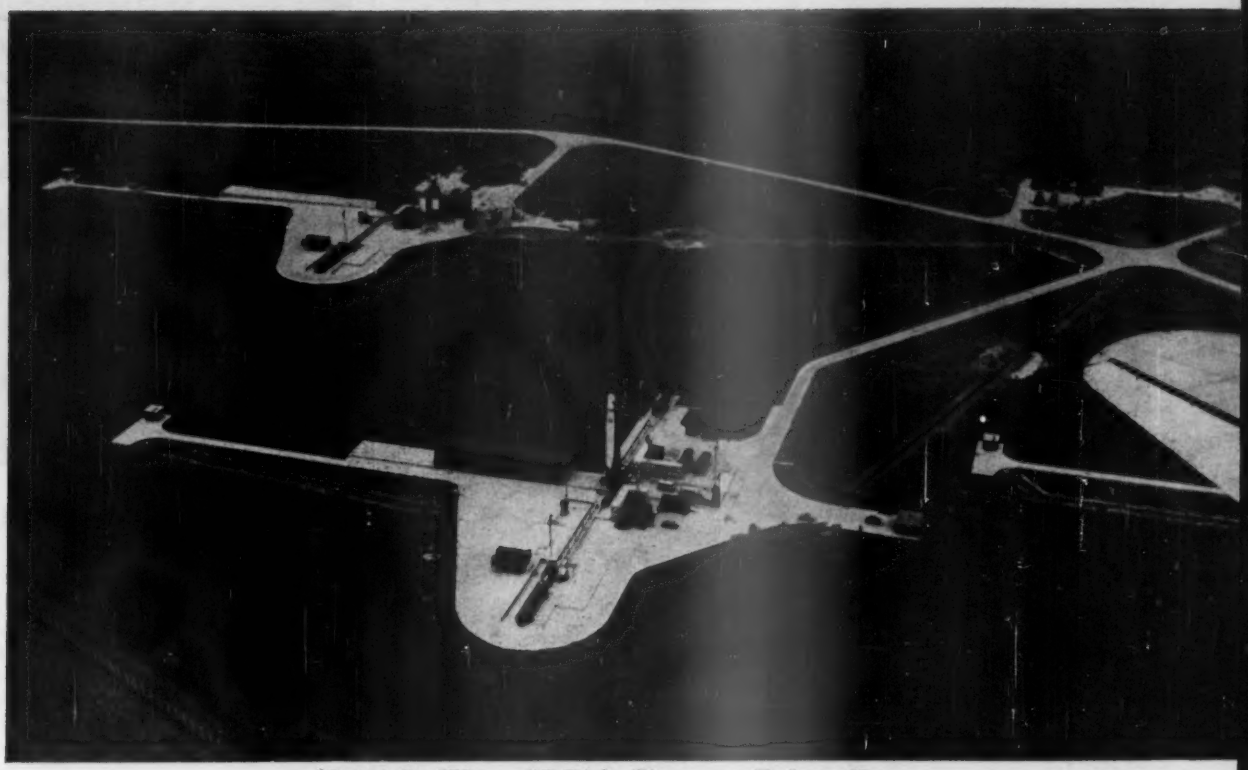


British Thor IRBM Site at Feltwell

One of five Thor intermediate range ballistic missile sites now operational in the British Isles (AW July 13, p. 29) is shown in the Feltwell complex. Nation eventually will have 20 sites. Each of the operational units has three missiles and three pads.

cal literature for technical intelligence.

Peace is not a vacuum, Leghorn believes, and this view takes a more sophisticated approach to disarmament than the beat-the-guns-into-plowshares idea of the 1920s and 1930s.

Thus defense systems would be designed to introduce arms stability, not eliminate them. The highly complex intelligence systems would have three broad tasks:

- **Warning of operational systems;** that is, to provide exact data on what types of weapon systems are in being in other nations. This would include surveillance of such things as missile launch sites and aircraft movements to give warning of intentions.
- **Providing data on numbers** ranging from force levels to production levels.
- **Providing technological** development information.

Balance of Power

With reliable data from all three levels—which implies the agreement of all parties either to allow it to be obtained freely or to disclose it—it thus becomes theoretically possible to match one's own forces precisely to the enemy's capabilities and gain a near-perfect balance of power.

A certain amount of good faith among the parties seems necessary, though basing the system on a highly sophisticated intelligence net does take into account human fallibility or duplicity.

Should such a system be successfully introduced, the initial cost for the necessary expensive components would be high, at least initially. But in theory it would also become possible to reduce security costs as the intelligence systems become more efficient since defense spending would then be required only to meet precisely known threats and not any number of any capabilities of which only a few might actually be intended for use.

The Thompson Ramo Wooldridge view was voiced by Dr. Simon Ramo, executive vice president, at the dedication of the Intellectronics Laboratories, which are headed by Dr. John M. Salzer.

"In the 1960s," he said, "the major military projects will be in the intellectronics field. Just as greater bombs have given way to means for delivery and our concern with H-bombs has changed to a concern about intercontinental ballistic missiles, so the future will involve a concern and a battle for supremacy in intellectronics.

"We have already seen the attainment by the hostile camps of an adequate amount of force to make possible fatal destruction of the other and will soon recognize the assured capability for delivering this force. Control of the intelligence and the nervous system behind the delivery of force is now rising to that No. 1 position."

The Thompson Ramo Wooldridge laboratory will not be confined to developing such systems, but will work on various approaches to data processing, to machine translation of languages and to systems for airlines navigation and traffic control.

Itek's Plan

How Itek plans to fit itself into what it foresees as the market of the 1960s provides an example of industry thinking on adaptation to a swiftly changing technology—and some of the problems.

Unlike many companies which consider 50-50 as an ideal military-commercial breakdown for business, Itek uses a 70-30 ratio, but one that extends further than simply diversification.

- **Military business,** now running about one-third of Itek's total volume, would remain at that level ideally. Leghorn estimates the future military information retrieval market at $1 billion, and is aiming at a 5-10% share of that market for Itek.
- **Commercial** business is sought as the primary source of funds to maintain a research-based company. Under this system the company thus would be able

WANTED: 4 MEN FOR KEY POSTS IN ASTRIONICS

If ever an organization was designed from the start for space systems development and production, this one is.

Formed last August, *Chance Vought's Astronautics Division* already has made first deliveries on a NASA contract to provide *Scout* research vehicles.

For the future, four major lines of interest have been chosen: development of more *Scout*-type research vehicles; research payloads, including reconnaissance and astronomical satellites; manned space vehicles, and long-range studies to anticipate future needs.

This is a self-sufficient, self-managing division. *A few key posts are being filled now with men who can both mold the organization and direct its space programs.* Four such men are needed to fill these astrionics positions:

1. ***Senior Specialist for Navigation and Guidance Group.*** Advanced E.E., Ph.D. preferred. Experience in stellar navigation and star tracking systems techniques and in RF guidance and inertial navigation systems. To organize this area of divisional activity, handle conceptual design.

2. ***Senior Specialist for Communications and Detection Group.*** M.S.E.E. preferred, familiar with space communication systems, antenna systems and wave propagation in fields of radio frequency, microwave, ultraviolet and infrared systems. To develop and lead this area of divisional activity.

3. ***Astrionics Staff Scientist.*** Ph.D. preferred. To conduct advance theoretical analysis and apply advance technology in navigation and guidance, communication and detection, and automatic controls.

4. ***Guidance Systems Engineer.*** Physics or E.E. (M.S. preferred). Experience required with stellar guidance systems for space applications and with analytical and equipment systems. To conduct guidance analysis.

To inquire in complete confidence, write:

J. R. Clark, General Manager,
Astronautics Division
Dept. M-40

CHANCE VOUGHT
DALLAS, TEXAS

to control its own destiny, its president believes.

Earlier in the development of the company, Leghorn had estimated the company would need a minimum annual sales volume of $50 million at the 70-30 business-commercial ratio to give a self regenerating character as a research based company. Leghorn actually is aiming for a $100 million sales volume to bring the company into maturity.

Itek was initially financed two years ago by Laurance S. Rockefeller and his associates, a step which marked two trends for this venture capital group long connected with aviation enterprises.

One is a step further back on the development curve of a company for investment. Because of a growing search for "growth" companies by investors, venture capital groups like the Rockefellers are finding it necessary to go into a company while it is in a more embryonic stage than it has previously preferred.

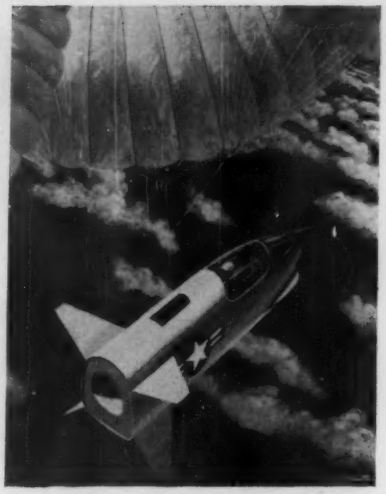
The Rockefeller group provided most of the initial $100,000 financing at the formation of the company in September, 1956, by Leghorn, Dr. Arthur W. Tyler —like Leghorn formerly with Eastman Kodak Co.—and Dr. Duncan MacDonald, dean of the Boston University Graduate School and former director of the company's physical research laboratories. Following usual practice, the Rockefeller group put the company in touch with an experienced financial man, Jesse X. Cousins, formerly with Stroukoff Aircraft, who became vice president and treasurer. However, the company operated with fewer than 10 employes the rest of that year.

Investment Worth

An estimate described as "in the ballpark" puts the total Rockefeller investment in the area of half a million dollars. At today's market prices of $45 to $50 a share, this investment on paper is now worth in excess of $7 million. However, the Rockefellers are essentially locked in for a long period of years because any attempt to sell a substantial part of this interest before the company has firmly established itself would drastically knock down the market price. Investor confidence produced by the Rockefeller financial backing undoubtedly played a major role in enabling the stock to reach prices over $200 a share before a five-for-one split was authorized.

Early in 1958 Itek acquired the physical research laboratories and staff of Boston University. Major defense cutbacks coupled with the fact that the laboratories were becoming involved in hardware programs led the university to discontinue the operation.

Next, Itek acquired Vectron, a fabricator of highly precise electromechanical equipment, which was then in



VOUGHT CONCEPT UPGRADES COCKPIT ENVIRONMENT

Prime goal of the Vought capsule concept is to improve the environment within the cockpits of future manned aircraft and spacecraft. This is imperative to keep up with the "state of the art," for, while aircraft capabilities are increasing rapidly, man's capabilities remain fixed.

Vought's capsule provides shirt-sleeve comfort and freedom. Simplicity and increased efficiency are its guiding basic features. This contrasts with the 95 pounds of environmental and escape gear with which today's pilot frequently must burden himself. In long-range aircraft and in missions stretched by aerial refueling, this burden penalizes pilot performance. In space flights lasting days or weeks, such encumbrance would be unbearable.

In the Vought concept, protection is in effect at any altitude and speed that modern aircraft can reach. It extends to the runway and, in the event of a ditching, even to water. Such survival equipment as rations, clothing and supplies will keep the downed pilot safe and comfortable until rescue arrives — and extensive emergency communications equipment will hasten that recovery.

Environmental and escape systems are specialties in Vought Aeronautics. This division also develops manned aircraft, atmospheric missiles and antisubmarine apparatus. Other major interests are being advanced in the company's Astronautics, Electronics, Range Systems and Research Divisions.

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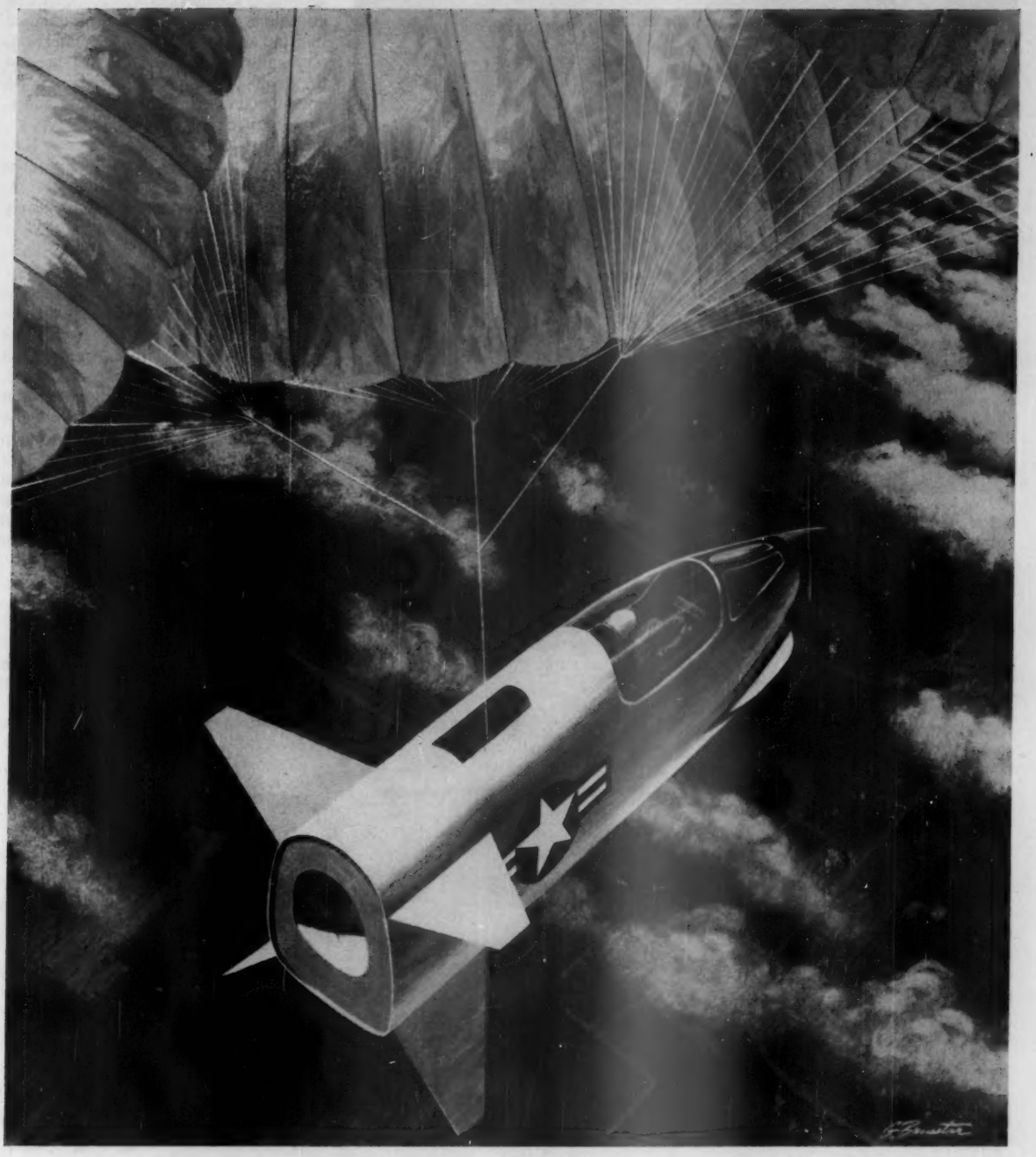

NAVY GIVES SAFETY A HIGHER CEILING

A new concept may enable Navy flyers to escape stricken aircraft as shown above. The pilot has triggered a shaped charge which sheared his cockpit free of the aircraft. Inside his parachute-borne capsule, he remains safe from windblast, killing cold and pressure. He breathes the same ideally conditioned air that sustained him before detaching. This tough bubble of life-nourishing atmosphere provides more than escape. It reverses the trend to increasingly burdensome personal gear. By allowing the pilot shirt-sleeve efficiency, the cockpit makes the entire weapon system more effective. This concept is under development today in Vought Aeronautics, a division of Chance Vought Aircraft, Incorporated.

AERONAUTICS · ASTRONAUTICS · ELECTRONICS · GENESYS CORP · RANGE SYSTEMS · RESEARCH

CHANCE VOUGHT
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Marines Order Lockheed GV-1 Hercules

U. S. Marine Corps version of the Lockheed Air Force C-130B Hercules, designated GV-1, will be built under a $19,200,000 Navy contract at Lockheed Aircraft's Marietta, Ga., plant. Powerplants are four Allison T56 turboprops. Range is 4,300 naut. mi.

straitened financial circumstances. Primarily this was a move to acquire Vectron's modern plant in Waltham, Mass., now Itek's headquarters, to give the company the status with the military of a "reliable contractor." However, it brought with it Vectron's contracts with Hughes Aircraft Co. for electronic subassemblies for the Falcon missile.

This year Itek acquired Photostat Corp. of Rochester, N. Y., which it visualizes as an important source of commercial business. It also acquired an 88% interest in Vidya, Inc., a company started by former National Aeronautics and Space Administration employes at Palo Alto, Calif., as an entry into the space field. Vidya now is studying a new type of plasma application.

Selling Research

Part of Itek's business is the sale of research as a product—the second of the two trends noted for the Rockefeller group.

Itek does not represent the furthest venture in this direction since hardware plays a big role in Itek's military and commercial volume. It has just unveiled a breadboard model of a device for handling and scanning small chips of film for information. Scanning can be done at a rate of 500-1,000 a second compared with 20 or 30 a second for some other systems. The entire system is called Itekard and includes a feed-in system, a processor, and storage unit and a search selector. Its major advantage is that it will be able to store graphic information as such, rather than requiring conversion of data to a numerical or coded storage system.

An equally recent Rockefeller investment, Geophysics Corp. of America, which utilizes Itek's administrative staff but so far has no other connection, represents a much greater distance on the road to selling only research. So does General Applied Science Laboratories, Inc., a Long Island, N. Y., group in which Dr. Theodore von Karman and Dr. Antonio Ferri of Brooklyn Polytechnic are interested. This Rockefeller-backed group plans to stick purely to research as a business.

Systems Approach

Itek is organized around the systems approach in its primary field, which is information retrieval. (The name Itek is coined from the words information technology.) In systems like its Itekard, it will use existing equipment when suitable kinds are available but will use its own electronics capability to develop new equipment that doesn't exist.

Photostat probably will be oriented more toward hardware. It now deals in various papers and chemicals and contemplated development will call for production of specialized equipment.

In optics and photography, the company does grind lenses and develop other hardware, but this operation is strongly directed toward research, though not necessarily the sale of it.

This organization tests resolution

Army to Test HU-1A Attack Capability

Development of Bell HU-1A turbine-powered helicopter's tactical capabilities to include its use in fire suppression on the battlefield will be tested by U. S. Army's Rocket and Guided Missile Agency at Redstone Arsenal and the Army Aviation Center at Ft. Rucker. Bell has fitted an HU-1A as shown with a missile rack extending from each side of the helicopter, permitting carriage of six French Nord SS-11 solid-propulsion remote-controlled rocket weapons. The 62.83-lb. SS-11 would be controlled to the target by the copilot-gunner over its effective range of more than 3,500 yd. Installation was performed by the company under an Army contract.

qualities of film for manufacturers. But a more typical example of what Itek means by "research-based" company is the company-sponsored study the optics people are doing on photography in space.

Temperatures—extreme heat or cold—do not seem to present as severe a potential problem as dryness in a vacuum which might cause the film to crack or radiation which might streak the film. One approach being investigated is a non-liquid, non-silver salt emulsion which would not be sensitive to radiation.

No specific application is involved now, but the possibilities for military or commercial use are evident.

Information retrieval as a field already has generated competitive force, which has brought Itek as a young company into conflict with Western Reserve University, one of the pioneers in it. Western Reserve's Center for Documentation and Communication Research has carried on projects in various technical areas, one of the more prominent in metallurgy in cooperation with the American Society for Metals.

Western Reserve sponsored a conference last summer which included participation by Russians from the Soviet Academy of Sciences which is taking a strong interest in the problems of accurately abstracting and indexing for quick scanning by machine the 55,000 scientific journals, 60,000 books and 100,000 reports being published annually.

Both Itek and Western Reserve talk of establishment of information centers at key cities where equipment for machine storage and scanning could be maintained. Both are involved in the development of systems for precise methods of coding information so that it can be stored in present types of equipment.

It was a National Science Foundation grant to Itek in this latter area that led Allen Kent, associate director of the Western Reserve center, to make charges of duplication before the Senate Subcommittee on Reorganization and Internal Organizations last spring. The committee was holding hearings on a bill to establish a U. S. Department of Science.

The Itek program is an attempt to develop a language, called L-representation, that can be machine-stored. This uses the terms from functional calculus to divide things into functions, which include properties of and relations among things, and arguments, which include things having properties and things related.

Thus the subject "separation of polonium with diisopropy iketone" separations would be a function and polonium and diisopropy iketone each as arguments. By assigning symbols to each one, not only can the specific terms be symbolized and stored, but a relationship pattern can also be developed. Thus it becomes possible to eliminate unwanted references that might be produced by the scanner in less sophisticated systems.

National Science Foundation defended its grant by pointing out that the proposal was screened by 17 individuals with experience in the field, but the rivalry between the two organizations still exists.

Search Selector

Itek is using a search selector made by Computor Control Co., Wellesley, Mass. Western Reserve is working with General Electric in the development of the GE-250 selector in its programs.

One of Itek's principal problems is the rapid growth it has attained and the recognition investors have given this. As Leghorn said to a meeting of the Boston Society of Security Analysts on the subject of the stock price rise: "Let me say that we have been surprised, disturbed, proud and concerned."

By discounting Leghorn's future volume and profit goals as having already been attained in fact, investors have, in effect, forced a certain amount of pressure on the company to keep on growing—quickly.

This is an added strain on the ones usually encountered when a company's size is increasing—especially when a management accustomed to operating in a smaller environment suddenly is forced to deal with more people, more money and more complex problems.

Thus Leghorn has told investors of the potential for the company because of its participation in new areas of technology and its commercial diversification, but he also has warned them to take a careful look at Itek because none of the usual rules of thumb applies to the company at its present stage.

Indianapolis Computer Links Control Centers

Computer at Indianapolis, Ind., Air Route Traffic Control Center (above) has been tied into similar equipment at Washington, D. C., Cleveland, Ohio, and Pittsburgh, Pa. System is International Business Machines Ramac 650 and is first to automatically exchange information with other Federal Aviation Agency centers equipped with computers. At left in Indianapolis main control room are air traffic controllers, seated at the Ramac 650 computer. FAA says it plans to install electronic computers in about 30 other centers.

How Vertol
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Vertol is a company long established in the design and production of advanced VTOL/STOL aircraft and equipment. Recent credits to the design and manufacturing abilities of the company include the world's first successful tilt-wing VTOL aircraft and the creation of a new family of multi-turbine powered tandem rotor helicopters which are setting a new pace for rotary-wing transportation.

Allied Research, working in another dimension, directs its efforts into basic research, applying new concepts to the field of meteorology, nuclear weapons effects, physics, chemistry, weapons systems analysis, propulsion and other advanced areas.

Now, by integrating the diverse knowledge and abilities of these two rapidly-growing organizations, the complete Vertol/Allied capability extends from basic to applied research, through design and development, to engineering and final production.

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Subsidiaries: Allied Research Associates, Inc., Boston, Mass.
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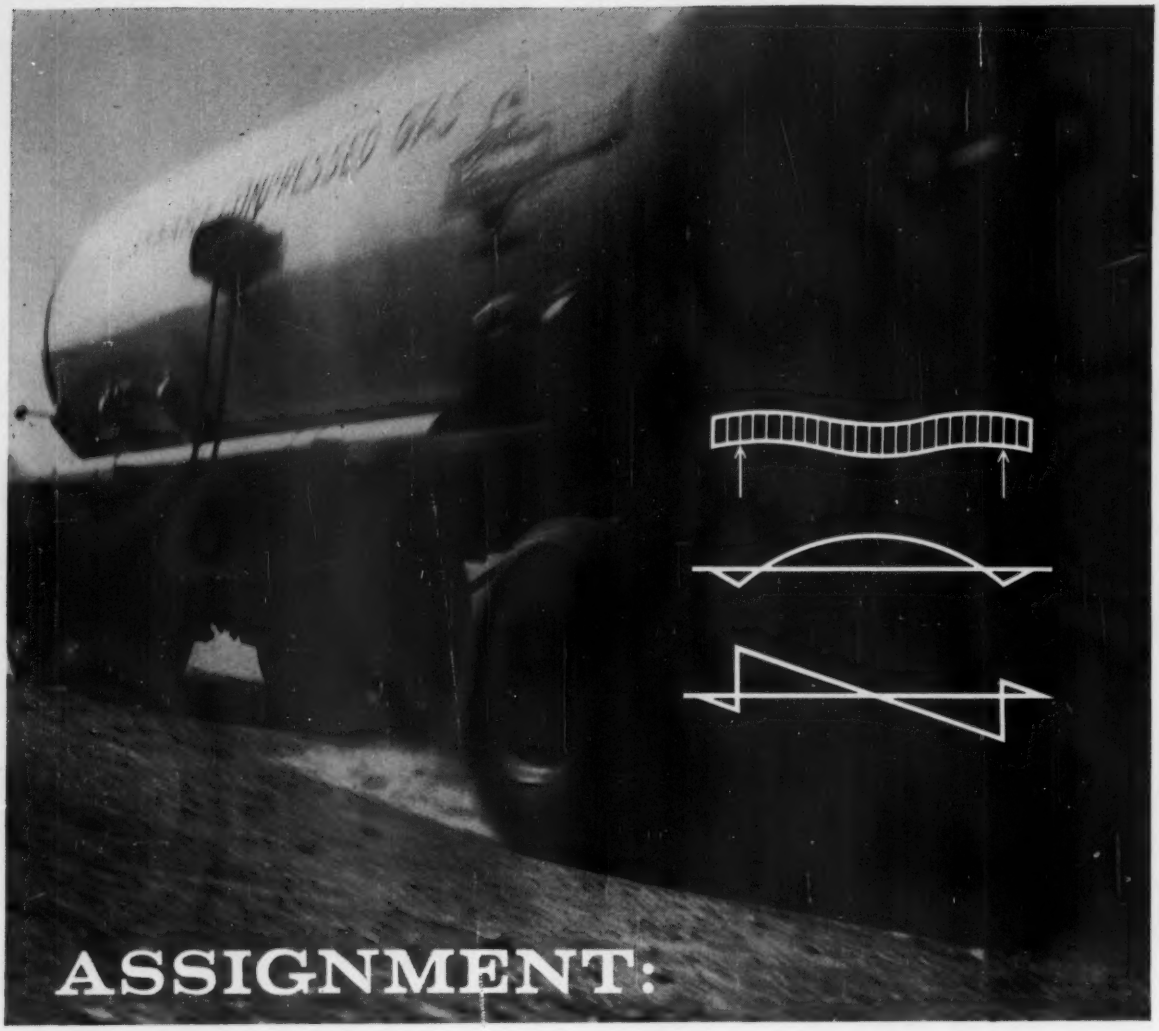

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Designing for maximum payload means taking maximum advantage of today's high strength steels. Experts who know these steels—from a practical as well as technical standpoint—can give invaluable assistance in the early planning stages. This is the job of our Application Engineering staff.

LPG transport tanks and power shovels are widely divergent areas in which Lukens engineers have helped increase payloads.

The use of Lukens "T-1" steel plate and heads in tanks for hauling LP-Gas has fostered an entirely new design concept in the tank truck field. This high tensile, high yield strength steel (100,000 psi) makes it possible to mount wheels *directly on the tank.* The dead weight of heavy underframes goes into payload.

Working with a major producer of power shovels, our staff suggested tough Lukens "T-1" for buckets, dipper sticks, bucket teeth and other key parts. Lightweight, welded steel plate—rather than heavy castings—added as much as 40% to load capacity.

From these successful projects—and many more—our Application Engineers have gained knowledge and experience of value to design engineers. That's why we say... *if your assignment is strength/weight, let it be our assignment, too.* Contact Manager, Application Engineering, J-129 Services Building, Lukens Steel Company, Coatesville, Pa.

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ASK FOR THE LUKENS "T-1" STEEL BULLETIN

SUPERSONIC model with canard is tested in the Langley 4 x 5 ft. supersonic wind tunnel. New NASA supersonic transport design concept eliminates need for a canard and uses a highly swept wing in place of the delta wing shown on this model.

NASA Studies Supersonic Transports

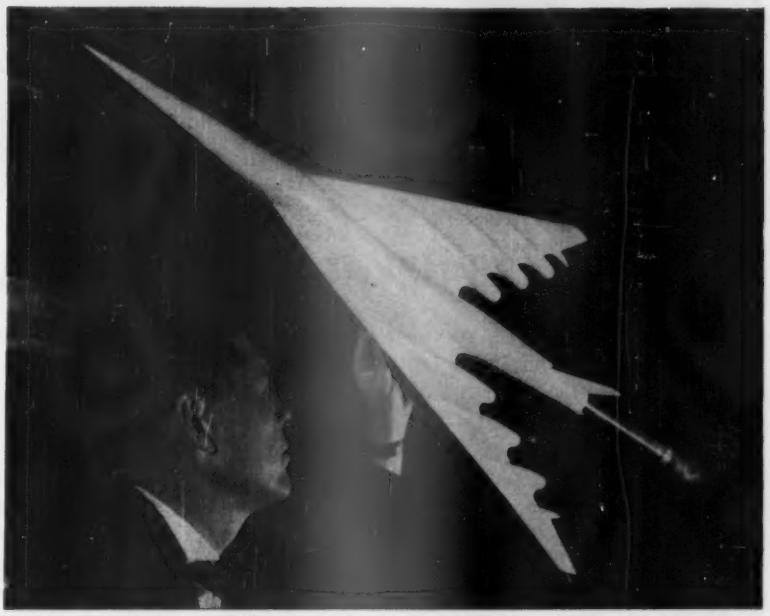
By Craig Lewis

Langley Field, Va.—New supersonic design concept has been developed by the National Aeronautics and Space Administration that puts an advanced swept-wing entry into the field of designs generally discussed for supersonic transports.

Visually similar to the transonic area rule design evolved here at Langley Research Center the supersonic layout is considerably more complex. It eliminates both the canard and horizontal tail surfaces and has a thin, carefully shaped fuselage and a highly swept wing with engines podded in the wing afterbodies.

A recent development, this super area rule concept offers higher lift-drag ratios than those for the delta wing of the type used on the North American B-70 Mach 3 bomber, a wing similar to the designs in most supersonic transport proposals. The B-70 wing design was laid down three to four years ago at a time when the new NASA concept did not exist.

This latest NASA contribution to transport design may be among its last in view of the sharply diminishing interest in aeronautical research. With



NASA supersonic transport design concept involves careful combination of wing design and fuselage shape. Fuselage shape is critical in the wing area, and the pinch effect generates low pressures over the forward part of the wing near the fuselage to aid lift. The whole wing plan is designed to keep lift over the forward section of the wing where airflow is most favorable. NASA researchers estimate this design has about half the drag due to lift of the supersonic delta wing such as the one used on the B-70.

The Navy's new versatile Vigilante

Roaming the oceans of the world aboard its carrier, the A3J Vigilante will fill an important dual role for the Navy. It can pinpoint its target in a brushfire incident... or pulverize it in an all-out conflict.

No other aircraft combines all the versatile capabilities of the new Vigilante—the Mach 2 all-weather attack weapon system built by the Columbus Division of North American Aviation.

It can launch nuclear weapons, conventional bombs, air-to-surface missiles—day or night, in any weather, at any attitude, from any altitude—at extended ranges from its carrier. Its automatic bombing-navigation system makes it super-accurate—for an undetected deck-level attack mission or one high in the stratosphere.

Besides versatility, speed, range, accuracy, the Vigilante also carries with it the human judgment of its crew—two highly trained Navy men who can report results, react to emergencies, and be redirected or recalled. Men who will make the Vigilante doubly dangerous in its dual role.

THE COLUMBUS DIVISION OF NORTH AMERICAN AVIATION, INC.

Columbus, Ohio

space programs absorbing the bulk of NASA funds and energy, and with declining military interest in new high speed aircraft, aeronautical research is headed for minor status in the agency which it once completely dominated (AW Nov. 30, p. 26).

Exception to this trend is VTOL research, which will continue as a substantial program. Prospects of a hypersonic transport could be among the most prominent casualties of the trend. If industry had to pay for and conduct all of the basic research necessary to develop a hypersonic transport, economic considerations might kill it even before its feasibility is established.

Although it is visually similar to the transonic area rule layout, the new NASA supersonic concept produces a design that is "an entirely new approach, a further extension of area rule ideas," according to Richard Whitcomb, NASA aeronautical research scientist and winner of the 1954 Collier Trophy for developing the transonic area rule.

Whitcomb told AVIATION WEEK that the supersonic concept reached the point where it appeared feasible a year ago, and that it has evolved into an efficient design within the past six months.

NASA supersonic transport is still a research model, but it has moved into fairly detailed design. Whitcomb said several aircraft manufacturers are studying it, but he also cautioned that it is a complicated design and must demonstrate distinct advantages to supersede the various designs proposed in earlier supersonic transport planning.

In its present form, the NASA supersonic design is for a Mach 2.2 transport. An aircraft in this speed range can be constructed of fairly conventional aluminum materials, while a Mach 3 transport will have heating problems severe enough to call for stainless steel construction. The debate over whether to build a Mach 2 transport or jump all the way to Mach 3 is a prime argument in the industry, and apparently only Lockheed Aircraft Corp. is committed to the Mach 3 approach so far.

The question is crucial, since the market for a supersonic transport is limited—possibly 100 or so aircraft—and market realities prohibit even the relatively limited number of entries now bidding for subsonic turbojet transport orders.

Wing on the Mach 2.2 model is swept 70 deg. at the leading edge. Speed can be increased by increasing the wing sweep, and a Mach 3 version would have about a 75 deg. sweep. Intricacy of the wing design is indicated by its slightly S-shaped span-wise profile, with an upward curve toward the

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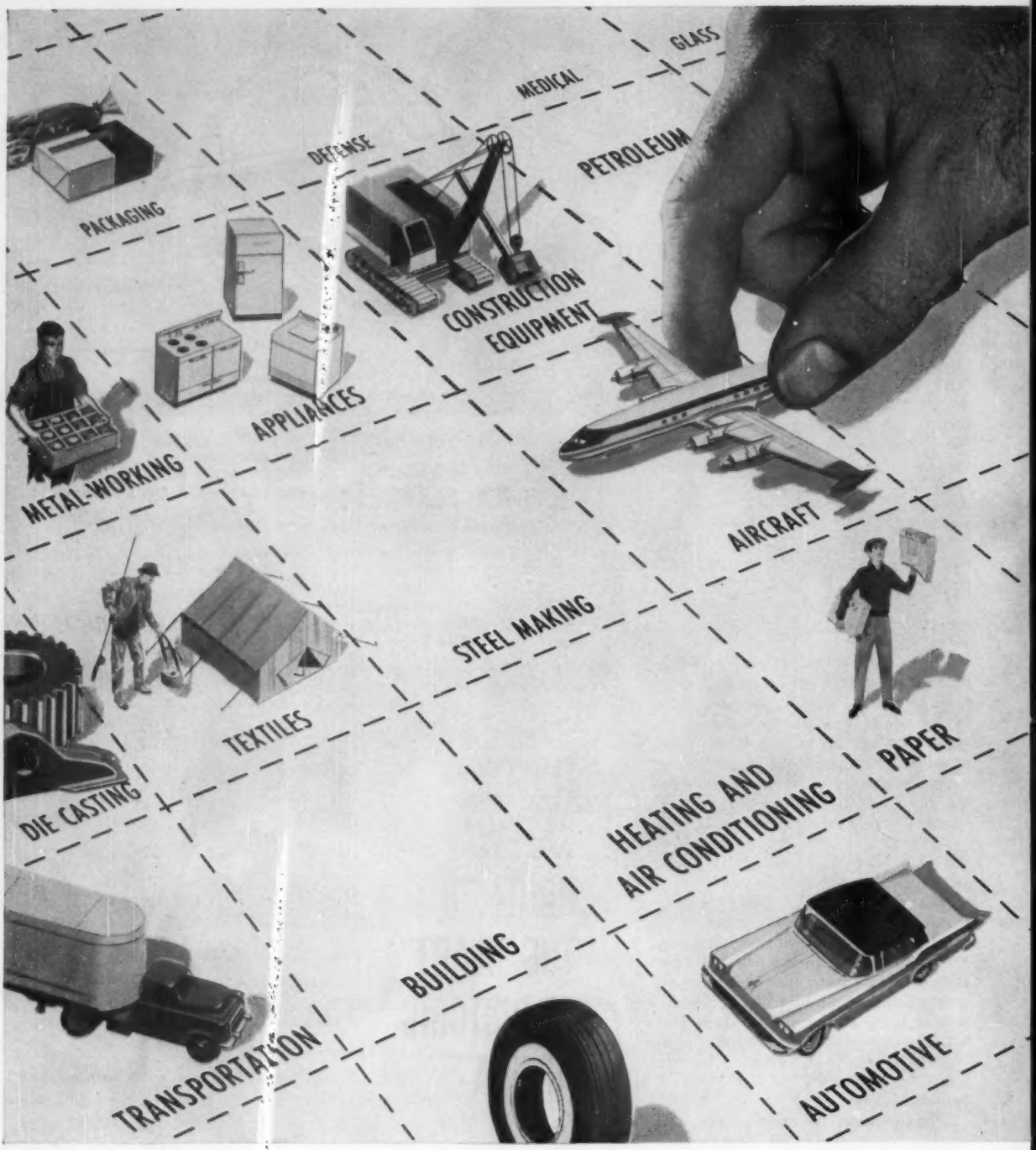
ETHIOPIAN AIRLINES

THE WONDERLAND ROUTE



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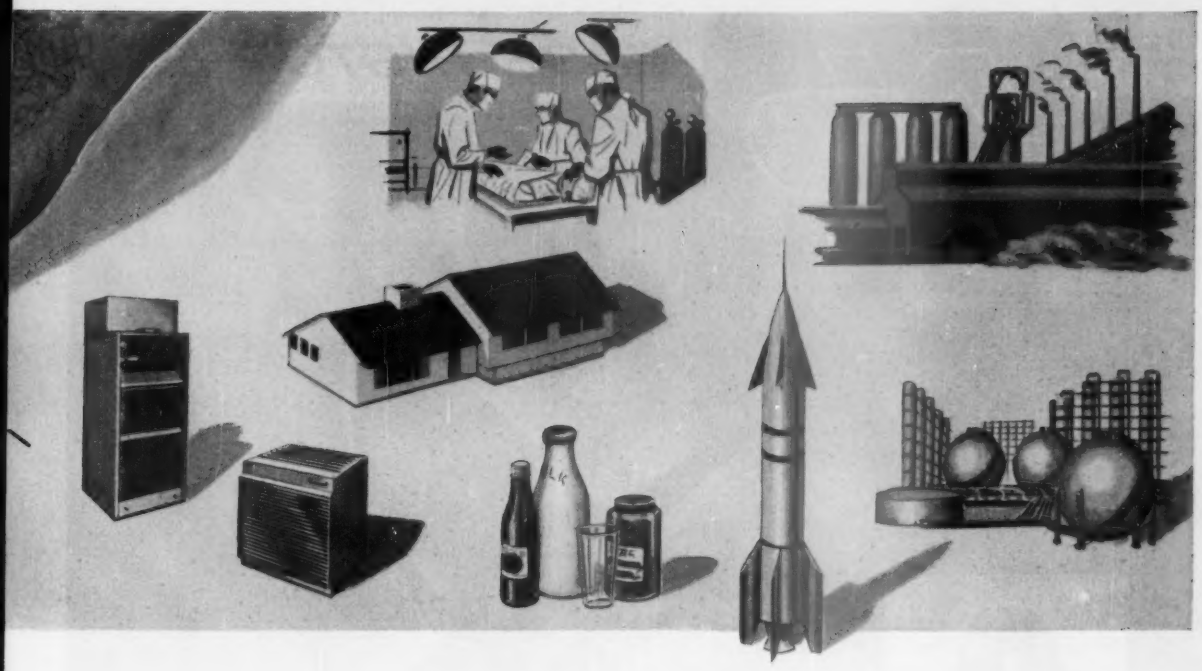

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On November 9, Midland-Ross Corporation acquired for cash the Surface Combustion Corporation, its Janitrol Divisions, and subsidiaries.

Midland-Ross's purchase of Surface is another step in its program of planned expansion into new products, services and markets. Surface and Janitrol fit this pattern ideally. No changes in management or operations are contemplated for the new acquisitions.

Already serving scores of industries, Midland-Ross will now add many other growth industries being served by Surface and Janitrol... steel-making, metalworking, ore processing, petroleum refining, glass, medical, and marine with Surface and Kathabar equipment... residential, commercial and industrial building with nationally advertised "Janitrol" oil- and gas-fired furnaces, unit heaters, and air-conditioning equipment... aircraft and missile with Janitrol Aircraft products.

Assets of the enlarged Midland-Ross organization are now over $70,000,000. Employees now total 5,800. Fourteen plants are located in six states and Canada. Sales in 1960 are forecast at more than $120,000,000.

For a copy of "Quick Facts about Midland-Ross, Surface, and Janitrol," write to:

-ROSS CORPORATION

Automotive frames; process and production equipment for the paper, textile, rubber, plastics, and foil industries; pneumatic controls and compressors for mobile equipment; power brakes; die castings; metal-decorating, laminating and painting equipment; steel-mill equipment and heat treat furnaces; industrial ovens; humidity-control equipment; residential, commercial and industrial heating and air-conditioning equipment; aircraft, missile, and ground-support heaters, heat exchangers, and controls.

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CASE HISTORIES

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The X-15 was developed by North American Aviation for the USAF, US Navy and NASA for research in the field of hypersonic flight. The same N/D engineering and manufacturing skills applied to solving *hot* and *cold* ball bearing problems of this first manned advanced research vehicle, are ready for *your* rocket or missile project *right now!* Call or write New Departure Division, General Motors Corporation, Bristol, Connecticut.

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fuselage and a downward curve toward the wing tip. Engines are podded in six wing afterbodies and are hung behind the wing structure for safety reasons. Intake ducts for the powerplants come through the main wing structure.

This highly swept wing design is aimed at stopping shock wave formation, thereby minimizing drag and smoothing air flow. The leading edge is swept behind the shock wave generated by the fuselage, and the wing flies in an airflow considerably slower than that in front of the shock wave.

Since the airflow is favorable for lift over the forward part of this wing design, the purpose is to keep it forward. Wing afterbodies are used to slow the airflow over the rear portion of the wing and keep the main lift forward. For the same reason, the large aft wing area characteristic of the delta wing is eliminated because it is inefficient. Whitcomb estimates the NASA swept wing has drag due to lift about half that of the B-70 type delta wing.

Fuselage shape also plays a key role in the wing lift characteristics. Whitcomb told AVIATION WEEK the swept wing is not superior to the delta wing by itself, but that it is superior when carefully combined with the wing afterbodies and the fuselage. The fuselage has a long, sharp nose which tapers out to the point where the wing leading edge is joined, then is pinched over the wing root and bulges to its greatest cross section near the wing trailing edge.

Cambered Fuselage

In contrast, the greatest fuselage cross-section with the transonic area rule is near the leading edge.

The fuselage curve over the wing is a critical factor in the supersonic design. Indenting the fuselage aft of the leading edge root generates low pressures over the large forward area of the wing near the fuselage. The fuselage is also cambered to produce lift forward and balance the aircraft. This eliminates the need for a canard.

Whitcomb originally wanted to carry passengers in the middle-rear area of the fuselage but found that some must be carried in the forward section for balance. He also has found that the nose section must be made longer and fatter to accommodate more people in order to make the aircraft a practical operational transport.

Horizontal tail surfaces have been eliminated along with the canard. The wing is swept enough so that the tips are near the tail area, and elevons can replace the horizontal tail surfaces, leaving only a vertical tail surface for directional control. The whole outboard wing panel serves as an elevon by pivoting around a spanwise axis at about the one third chord point. Mechanics for the elevon are housed in a pod which forms the outboard wing afterbody.

A Mach 2.2 transport using the NASA concept would be in the same 300,000 lb. gross weight class as present intercontinental subsonic turbojet transports. Whitcomb describes it as an aircraft that would have about the same range as present jets, but one which would be much faster. This makes it a transcontinental and transatlantic nonstop transport. Greater speed will require more runway unless NASA develops some means of shortening takeoff roll for its supersonic design.

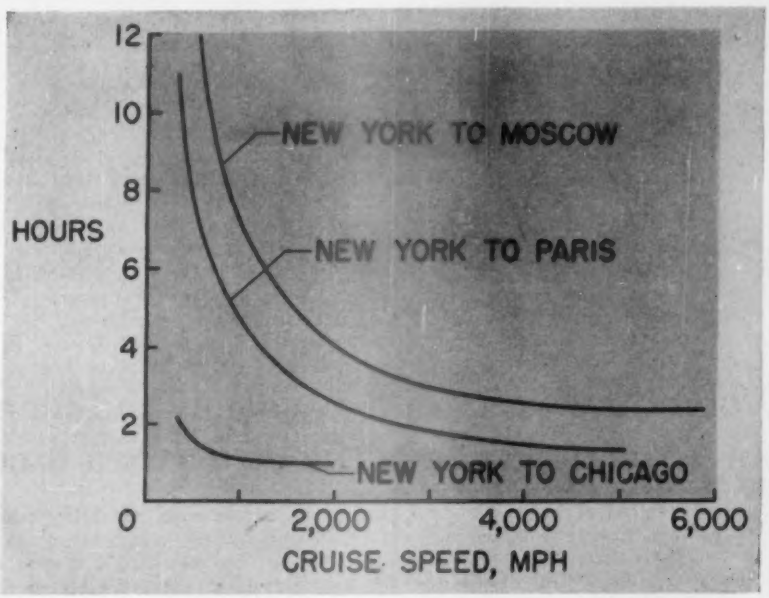
During the recent triennial inspection here, NASA researchers expressed confidence that, despite discussions of rocket-powered transports, most air transportation will take place in aircraft that will cruise in the atmosphere powered by airbreathing engines. NASA said it is continuing to emphasize research to advance performance characteristics of such aircraft.

Langley researchers charted speed versus elapsed flight time and pointed out that, among the high speed transports, the current subsonic turbojets operate close to the optimum speed for such short hauls as New York-Chicago, but as range extends to such distances as the New York-Paris route, a supersonic transport could fly it in less than half the time required by current jets. Thus, the supersonic transport would produce a dramatic reduction in flight times over the long-haul routes it would fly, and NASA observed that, if they are built, supersonic transports will offer the largest increase in transportation speed ever made.

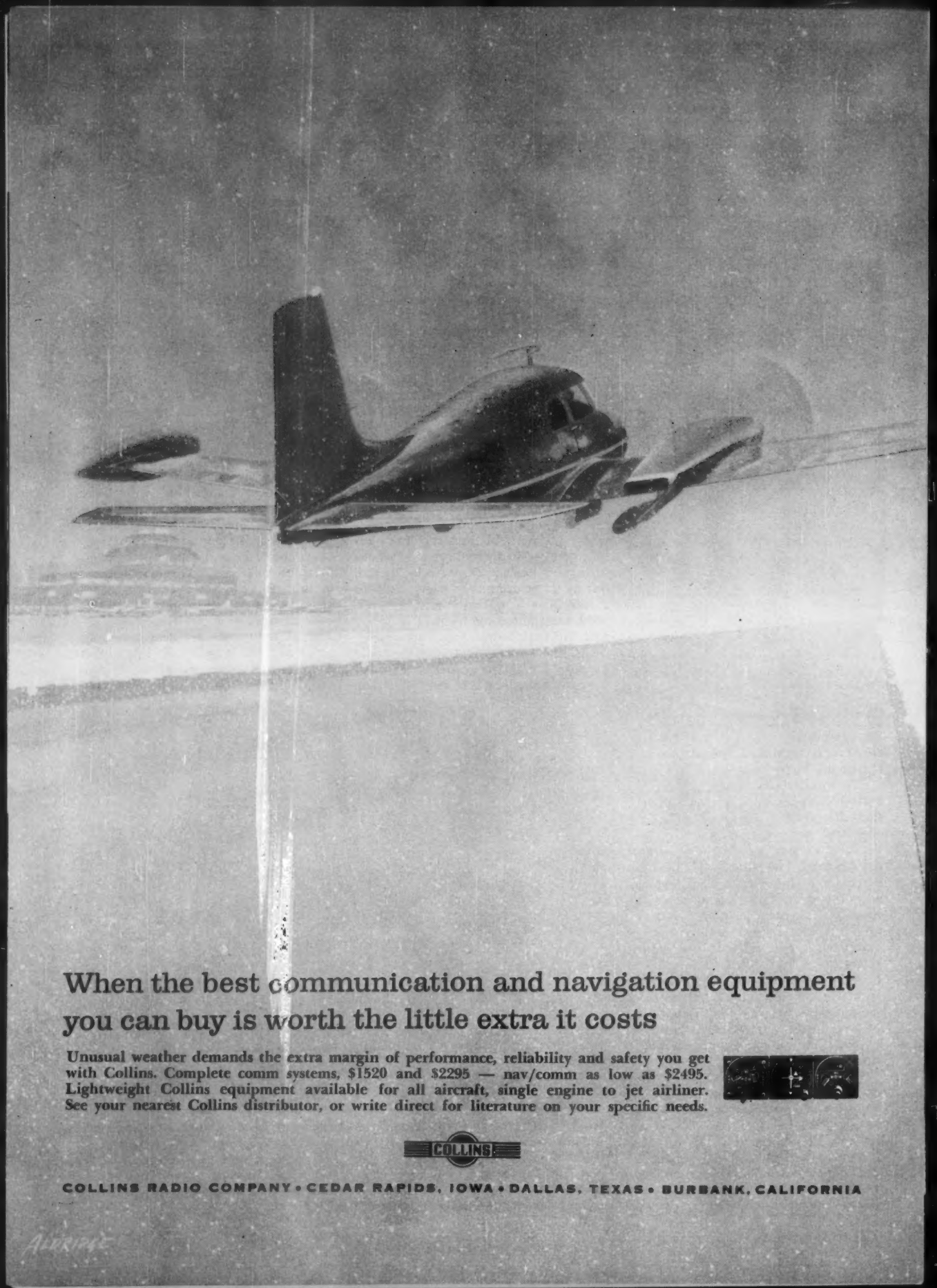
On a route as long as New York-Moscow, the hypersonic transport offers substantial time savings over the supersonic airplane, although they are not as dramatic as the jump from subsonic to supersonic. With flight times already cut to comfortable limits by the supersonic transport, the need for further time cuts might be outweighed by the very great expense and technical effort required when the time comes to decide whether air transportation will move on to hypersonic aircraft.

From its research, NASA has concluded that supersonic transports with flight efficiencies comparable to subsonic turbine transports appear to be technically feasible. Researchers said there are technical problems other than flight efficiency to be considered but that none of them appears insurmountable. They also pointed out that the "economics of acquisition" will play a large part in determining whether a supersonic transport ever goes into service.

Discussing its approaches to various drag problems with supersonic transports, NASA said wave drag can be minimized by using long, thin wings and fuselage or by sweeping the wings back at a large angle. Reporting substantial reductions resulting from attempts to cut drag due to lift, NASA cited its new supersonic transport concept and the technique of flattening the



NASA chart shows how flight time decreases as aircraft speed increases over three representative route segments. Curves show that there is little gain in time at speeds higher than 700 mph. between Chicago and New York and that time gains are small on the New York-Paris route as speed goes above 2,000 mph. Hypersonic speeds improve time performance on the New York-Moscow route, but the gains are less dramatic than those between subsonic and supersonic transports.



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top of the fuselage to produce lift more efficiently and help the wing as two approaches in this area. The flattened fuselage approach has been adapted to the B-70.

Friction drag is another problem, and NASA warned of the need for extremely smooth surfaces on supersonic transports to minimize this factor. Whitcomb told AVIATION WEEK several manufacturers are developing techniques for smoothing aircraft surfaces, and he pointed to the Convair B-58 as an example of progress in this area. He observed that any supersonic airplane must be smooth if it is to have any range.

Hypersonic Research

Work on hypersonic transport research is in a considerably less advanced state than the supersonic work. NASA has reached the point of testing simple models in wind tunnels, but the technical feasibility of such aircraft has not yet been established. NASA will study drag characteristics of various configurations, as well as problems of stability and control of complete vehicles.

Heating will be a severe problem with a hypersonic transport, and NASA researchers point out that temperatures in the ramjet engines will be higher than those encountered by the aircraft itself. At Mach 6, they estimate the temperature in the combustion chamber at about 4,600F. Since these temperatures are beyond the capability of stainless steel, the engine will have to be made from a refractory material, probably with ceramic liners in the combustion chamber and exit nozzles.

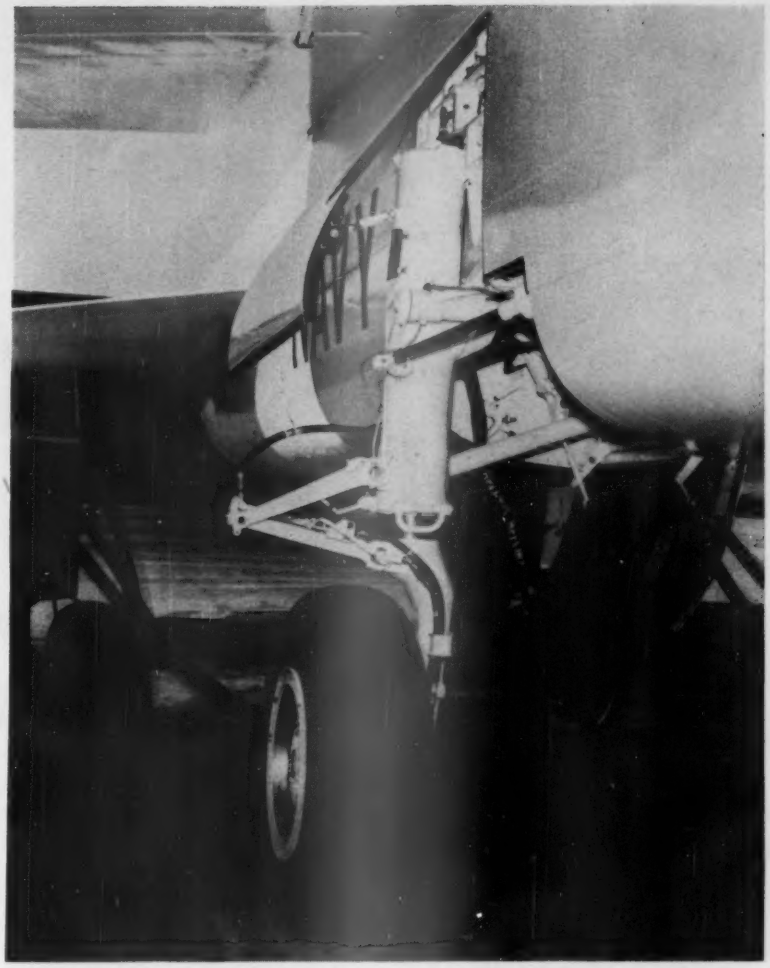
Even with exotic materials, NASA thinks a cooling system will be necessary.

One scheme involves perforating the engine cowling to allow the hot inner surfaces to radiate heat directly to free space. Above Mach 6, NASA feels a mechanical cooling system will be needed for the engine and possibly the airframe.

Fuel can be circulated through hot areas to cool them, but the usual kerosene fuel will break down at the temperatures expected so that another fuel would have to be used. Hydrogen would be good for cooling and as an energy source, but the aircraft would have to have a very large and bulky fuselage to carry enough of the very lightweight gas.

NASA has done considerable research in transonic transport designs, but this work is almost finished. Whitcomb points out that researchers have reached the ultimate shape from the aerodynamic point of view. Some use of the transonic area rule concept has been made with the wing afterbodies on the Convair 600, but there appears to be little prospect that other designs will be produced using the complete concept with its shaped fuselage and with engines podded in wing afterbodies.

NASA estimates that these area rule features could increase cruise speed of current turbojet transports about 100 mph., considering only cruise efficiency. Such other factors as extra weight and flutter would have to be considered before over-all performance gains and economic advantages could be assessed.



A3J Utilizes High-Strength Steel Landing Gear

Main landing gear of the North American A3J Navy attack aircraft utilizes Strux high strength steel alloy. Strux, developed by U. S. Steel Corp., is used for the outer cylinder, inner cylinder, fork and a trunnion. The nose gear utilizes the material in its piston and fork. The Bendix landing gear is operated pneumatically by compressed nitrogen.

Admiralty Evaluates British Hovercraft

London – Saunders-Roe Hovercraft air cushion vehicle (AW Sept. 14, p. 30) has undergone a three-day evaluation by British Admiralty scientists to assess operational potential of the vehicle.

Plans to develop the Hovercraft commercially were announced by the sponsors, the National Research Development Corp., but financial backing for the project still has to be negotiated, Deputy Director Dennis Hennessey told AVIATION WEEK. Discussions are proceeding with a number of industrial firms.

Immediate development of the craft is likely to be in the form of relatively small units not exceeding 100 tons which would be suitable for operating in undeveloped regions.

Designs have been completed, Hennessey said, and could be available commercially by 1963.

Inventor of the Hovercraft, Christopher Cockerell, said here recently that the American designs currently flying are "all very primitive, just capable of lifting one man, but certainly not capable of going from A to B."

Reverse-thrust of jet-powered propellers brake "Ski-130" transports to short, safe stops. Giant skis, fitted over landing wheels, retract to permit landings on or takeoffs from surfaced runways.

Heavy steel structures, pre-fabricated in 40-foot sections, were part of DEW Line cargo airlifted from Sondrestrom AB, Greenland by 61st T.C.SQ. of the Tactical Air Command's 9th Air Force.

Airlift in action:

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Flying through 40-below storms and fog, Lockheed-built C-130 HERCULES transports of the U. S. Air Force ski-landed 26 million pounds of cargo on Greenland's ice cap. Tractors, trucks, machinery, tools, pre-fabricated radar towers and buildings, lumber, cement, crates by the hundred—plus the personnel needed to build two vital new DEW Line bases. Mission accomplished (ahead of schedule), the "Ski-130" planes headed for Antarctica to support a U. S. Navy expedition.

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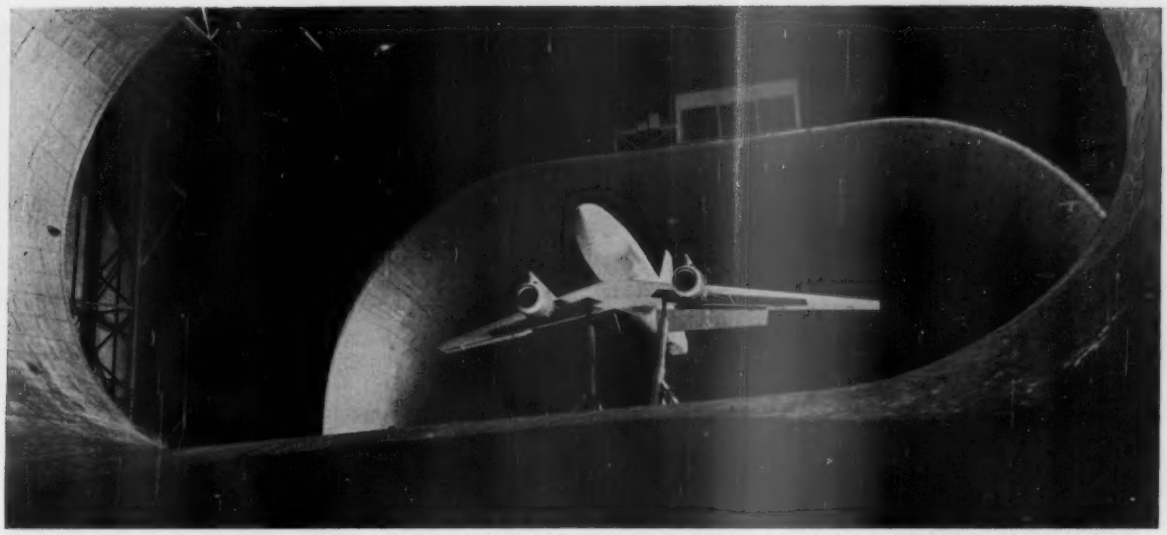


MODEL with 32 ft. wingspan and two J69 engines is used in jet flap research at NASA Langley Research Center. Test will be conducted with both half span and full span flaps.

NASA Begins Advanced Jet Flap Tests

Langley Field, Va.—Jet flap research is moving into a new, large scale test stage here which will provide more realistic simulation of conditions met by a turbojet transport which might use this STOL technique.

National Aeronautics and Space Administration is starting jet flap tests in its full-scale wind tunnel here at Langley Research Center with a 32 ft. wingspan model equipped with two Continental J69 engines. Use of the large, swept-wing model and the hot exhaust stream of the J69 will provide a more realistic test than the research with smaller models and cold compressed air NASA has conducted here for several years (AW Oct. 22, p. 34).

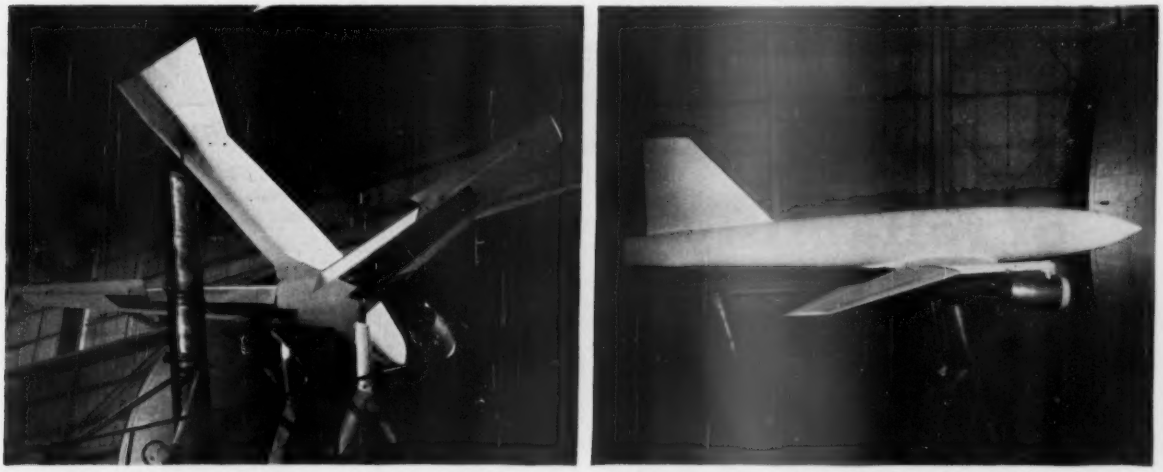
These latest tests are being conducted with the external flow type jet flap technique which uses engine exhaust deflected up over the wing flap to produce added lift and shorten takeoff and landing roll. NASA has also explored the technique of installing several small turbojet engines in the wing to exhaust from the wing trailing edge over the flap to increase lift.

Subsonic Use

The external flow type of jet flap technique could be most readily applied to such current subsonic aircraft as the commercial Boeing 707 and Douglas DC-8 and the military KC-135 and B-52. The new test series will provide more realistic data for possible application to these aircraft, although it appears that the technique has been developed too late for use in the current group of large, subsonic aircraft.

Model now in the full-scale tunnel has the same general wing design and flap configuration as the smaller models previously used. Tests will be conducted with both half span and full span flaps, and researchers will study different gaps and distances between wing and flap to find the optimum wing-flap relationship. Later tests may investigate tail size and position.

The two J69 engines, nominally rated at about 800 lb. thrust, are podded under the wings and hinged so they can be pivoted upward to direct the exhaust flow against the bottom of the wing, through the flap gap and over the



WING surfaces aft of the J69 engines (left) have Inconel-X water-cooled panels to protect them from heat generated by hour-long tests of jet flap techniques. Engines are tilted to direct exhaust stream up over the wing flaps. Flat exhaust nozzle (right) is formed by joining several small exhaust tubes.

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Sabrejet Used as Orpheus 12 Testbed

North American Sabrejet is being used as a flying testbed for Bristol Siddeley Orpheus 12 turbojet engine (AW Sept. 28, p. 57). Engine, which produces 8,170 lb. thrust with afterburner, was developed as a second generation strike fighter powerplant.

top of the flap. In actual use, the exhaust nozzle itself could be hinged to direct the exhaust flow upward from a fixed engine.

Bottom wing surfaces of the model have water-cooled Inconel-X panels in the area washed by the hot engine exhaust. These are to protect the wing from heat during tests which might run as long as an hour. In use, the exhaust stream would be deflected upward for only one or two minutes during landing and takeoff, and heat protection would not have to be as extensive as that provided for the model.

NASA has fabricated flat, flared nozzles for the J69s to spread the exhaust flow and direct it over the flap. Several small tubes leading from the engine exhaust are flattened and joined to form the nozzle. This is less efficient than a single nozzle, but avoids problems involved in using large areas of sheet metal under high temperature.

In operational use, nozzle design would be a key factor in a jet augmented flap system. The aim is to get the exhaust flow through the wing-flap gap, over the flap and spread over as wide a span of the flap as possible. The high velocity air can provide lift and also induce circulation over the wing ahead of the flap. This calls for flat nozzle shapes to flatten and spread the jet exhaust sheet.

Current nozzles are designed only to shape the airflow for flap purposes, but operational designs would have to consider cruise thrust efficiency and then be carefully tailored to the individual engine involved. Nozzles would have to be designed for low duct losses to keep the loss in cruise efficiency low. Even with an efficient nozzle, using the jet flap technique will mean trading some cruise efficiency for the STOL capability gained.

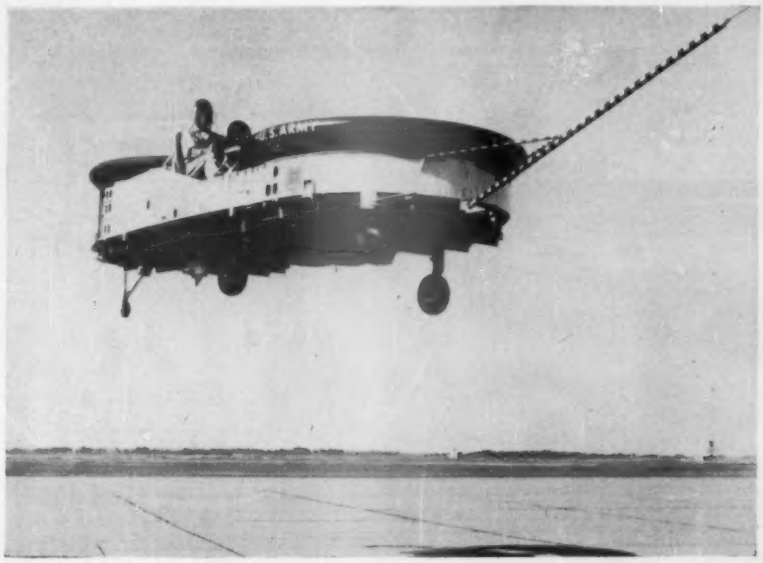
Earlier tests indicate the gain in STOL capability would be substantial, and present tests are being run to verify these results. NASA estimates from its calculations that a 707 could cut its takeoff and landing roll in half with lift coefficients of three to four. Next step after the current tunnel tests would be flight testing, but there are no current plans to carry the program into this stage.

NASA researchers have flown flight models with lift coefficients as high as 12.5, and the configuration looked feasible from the stability and control standpoint. A control jet in the nose was required during tests at $C_\mu 12$. With the jet flap technique, high circulation induces downwash, and increased horizontal tail area would probably be required to maintain controllability.

Tests indicated that an aircraft could be trimmed with its horizontal tail up to about $C_\mu 3$, and past that point, nose jets or some other technique would have to be used for trim. The canard might be a better approach, but it has some stability problems not present with a horizontal tail, and the canard itself would also require a jet augmented flap. Directional stability is not considered a problem.

The external flow jet flap system could be retrofitted to current transport and bomber designs to produce the dramatic STOL capability calculated for it, but a number of factors involved in installing and operating it must be balanced before a final economic and technical evaluation can be made. Loss in cruise efficiency from the flat nozzle is one factor, and the weight added by the nozzle and other hardware is another. Long term problems of heat and acoustic fatigue on the bottom wing and flap surfaces would probably require some structural beefing and new materials.

Noise is a further consideration, since the exhaust stream is blown over the bottom of the wing and it would be noisy under the aircraft. This probably wouldn't be a major problem because the jet flap would be used only for short periods after takeoff and before landing, and most of this time would be spent inside airport boundaries.



Piasecki Platform Starts Yaw, Speed Tests

Airspeed and yaw indicator probe has been added to the Piasecki VZ-8P flying platform in another phase of Army research program. Platform now uses a Turbomeca Artouste IIB turbine (AW July 13, p. 129); highest altitude so far is 20 ft.

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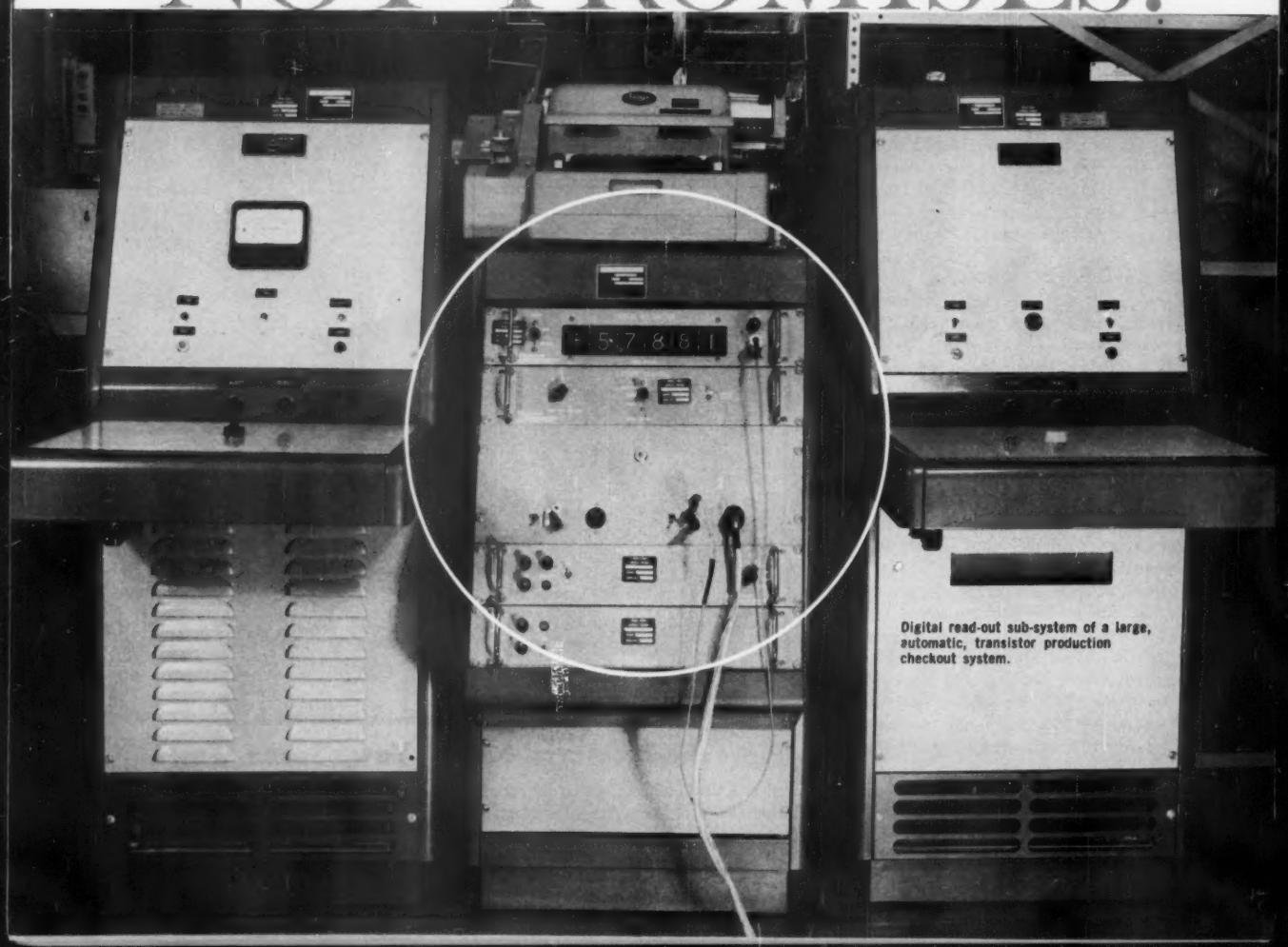
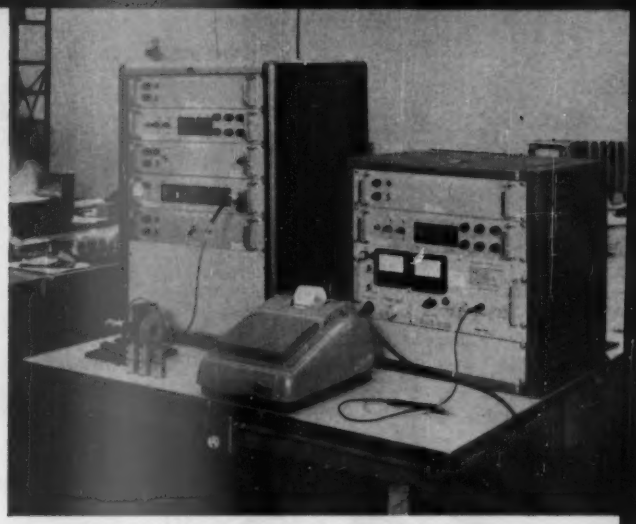


Digital read-out sub-system of a large, automatic, transistor production checkout system.

Sub-system for the ground support equipment on the B-58 **Hustler** program. Measures AC and DC single-ended voltages and ratios, and AC and DC differential voltages and transients. Chosen for its excellent operating characteristics under adverse environments.



Resistance measuring system – Used as a secondary standard to make accurate, resistance measurements required for checking linearity of multi-turn potentiometers.

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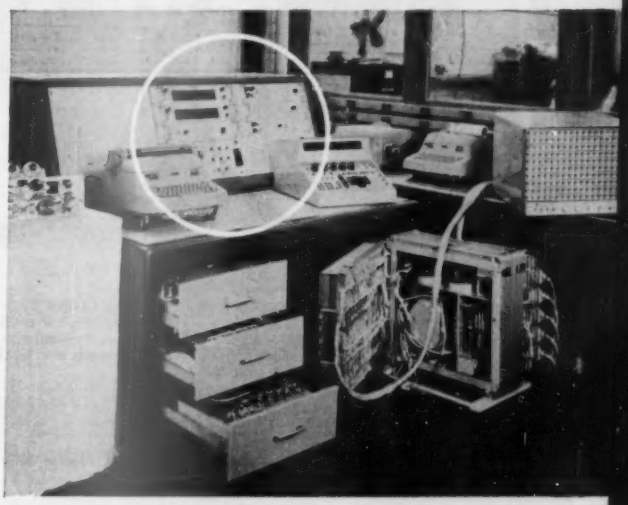

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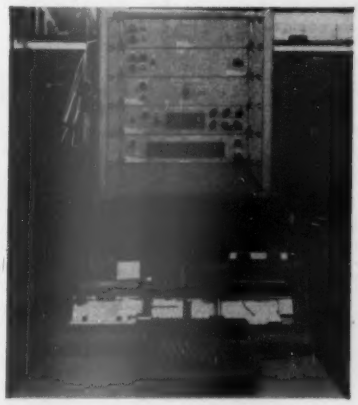

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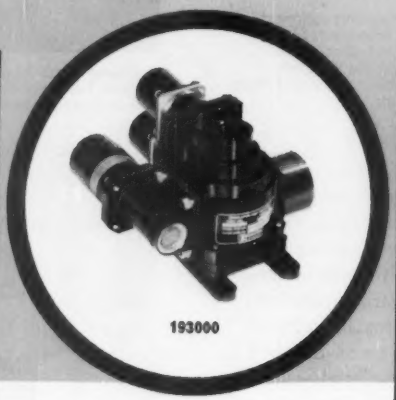

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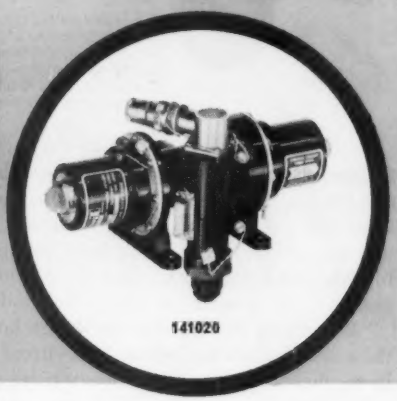

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General Information	Available with Solenoid Shut-Off and Position Indicators	Integral Relief Valve Solenoid Actuation Optional	Available with Solenoid Shut-Off, Relief Features, etc.
System Medium	Air, Nitrogen or Helium	Air, Nitrogen or Helium	Air, Nitrogen or Helium
Pressure Data			
Regulating Range (Typical)	13-25 PSIG ±.5 PSIG	300-400 ±5 PSIG	30 to 55 ±.2 PSIG
Inlet Pressure	3000 to 600 PSIG	3000 to 600 PSIG	3000 to 200 PSIG
Proof	4500 PSIG	4500 PSIG	4500 PSIG
Burst	7500 PSIG	7500 PSIG	7500 PSIG
Flow	5-40 lbs./min.	6-24 lbs./min.	8 to 20 SCFM
Leakage			
Relief Port		10 cu. in./min.	2 cu. in./min.
Internal	10 cu. in./min. (when shut off)	10 cu. in./min.	1 cu. in./min.
External	Zero	Zero	1 cc/hr.
Temperature Range	−65° to +165° F	−65° to +165° F	−65° to +165° F
Vibration	MIL-E-5272, Proc. 1	MIL-E-5272, Proc. 1	MIL-E-5272, Proc. 1
Acceleration	20 G's (1 plane)	20 G's (1 plane)	20 G's (1 plane)
Weight	3.5 lbs.	3.7 lbs.	1.45 lbs.

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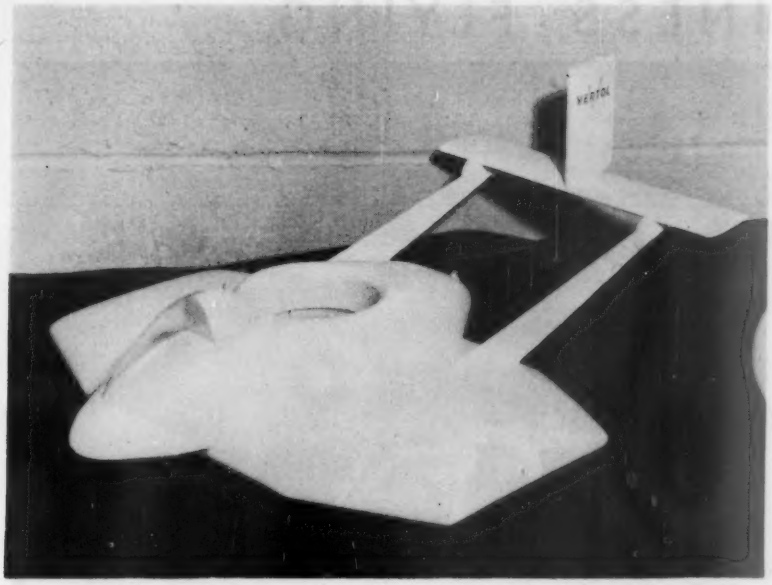

Vertol Ground Effect Vehicle Model

Wind tunnel model of a Vertol ground effect vehicle is electrically powered. Design envisions use of a ducted fan aft of the pilot's cockpit. Air is emitted from a slot around under edges of wing for ground cushion and from trailing edges for forward flight.

Soviet Press Raps Flying Auto Delay

Moscow—Russian press has issued another blast at Soviet bureaucrats who have refused to cooperate with the inventors of "flying automobiles."

Last summer, the government newspaper Izvestia charged that officials infected by "pernicious conservatism" were negligent in failing to carry through with work on a model ground-effect air car tested in 1955 by Gennadii Turkin, a petroleum engineer. Now, according to Izvestia, responsible officials are giving the brush-off to ideas advanced by Aleksei Smolin, an automotive engineer.

One of Smolin's "flying automobiles" has "pockets" on the sides containing a collapsible helicopter rotor which can be mounted "in a few minutes" on the car's top. "With such a rotor on the car top," Izvestia explained, "the automobile can rise into the air and cross a river, where it will continue its trip on wheels. The rotor is easily disassembled and put back into the pockets."

The Russian paper said this design of Smolin's has been available since 1953. "It is hard to explain why even an experimental model of it hasn't been built. Obviously, somebody's inertia is making itself felt."

Smolin has also been working on a ground-effect flying automobile "held up by two columns of air." Suction rings "up to 2½ meters in diameter" would be mounted on the car's roof.

"Three-bladed propellers driven by two automobile engines will suck in air and eject it powerfully through openings in the floor," Izvestia said. "Thus strong air streams are generated which lift the automobile off the ground and force it to ride in the air.

"Special louvers, which can give prescribed direction to air streams, will provide directional control and will easily turn the automobile any way desired."

Izvestia said that "flying automobiles" such as those designed by Smolin, are very necessary to Russian geologists in roadless areas. "Unfortunately, to date they exist only on the drawing board."

First French Aircraft Carrier Begins Trials

Paris—France's first aircraft carrier, the 22,000-ton Clemenceau, has begun its initial sea trials.

Slated for service in 1962, the carrier will be manned by a crew of 2,500 and will carry some 60 aircraft, mostly Dassault Etendard IV strike fighters and Breguet Alize anti-submarine aircraft.

The Clemenceau has a flight deck some 775 ft. in length and 135 ft. wide. A canted landing deck stretches about 500 ft. off from the regular flight deck at an angle of 8.7 deg.

Each flight deck is equipped with steam-type catapults which can launch a 15-ton aircraft every 30 sec. at a speed of 112 mph. Landing aid is mirror-type.

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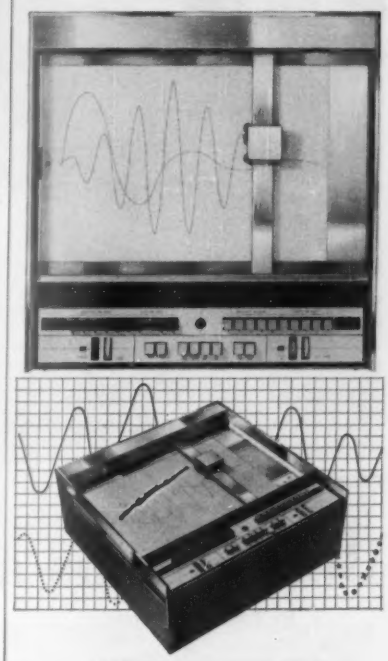
LIBRASCOPE X-Y PLOTTER MODEL 210

point plotting or continuous trace



OPERATING INFORMATION

Power: 115-volt, 60 cycle—180 watts.

Input: X and Y inputs isolated from each other and from ground.

Input Resistance: 2 megohms nominal on most scales. 1 megohm per volt on .5 millivolts per inch to .1 volts per inch scales.

Input Sensitivity: .5 millivolts per inch to 50 volts per inch with calibrated push button scales at .5, .1, 5, 10 and 50 millivolts per inch and .1, .5, 1, 5 and 10 volts per inch. Vernier controls permit continuous sensitivity adjustment between fixed scales, permitting full scale plotting for any sensitivity.

Accuracy: Static .1%, dynamic .2% at 10" per second.

Plotter Calibration Accuracy: .05% on all scales.

Slewing Speed: 20" per second.

For full details—dimensions, applications, list of accessory equipment, call our Sales Engineering Dept. or send for illustrated brochure on Model 210, XY Plotter.

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PRODUCTION line at Beech Aircraft Corp.'s Plant No. 2 at Wichita emphasizes the sharp upswing in business flying.

Beech Aims at $60 Million Sales Year

By Erwin J. Bulban

Wichita, Kan.—Calling 1960 "a year of decision" during which Beech Aircraft Corp. will lay the foundation that will determine its future in the prosperous but competitively tough decade ahead, Vice President-Commercial Sales Leddy Greever set a goal of more than $45 million in factory billings for business aircraft and parts before some 350 distributor and dealer representatives attending the company's annual sales meeting here.

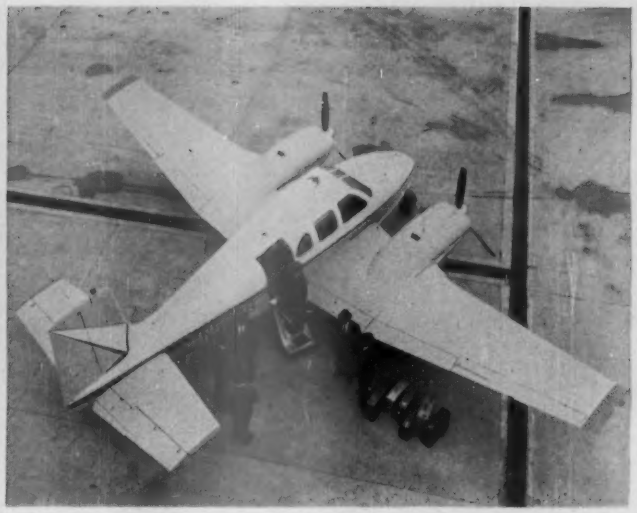
Achievement of this record goal will mean that, at consumer list prices, air-minded businessmen will spend a total of some $60 million for new Beech aircraft and equipment in 1960—more than double what they purchased from the entire industry a decade before.

In one of the hardest hitting sales talks he has yet delivered, Greever said there is no sign that there will be any cutbacks, but pointed out that there are other people in this business and nothing will come easy. To meet the goal of "$60 million in '60" is going to take an increased sense of responsibility on the part of the entire sales organization and greater enthusiasm to sell all of these new aircraft, he said.

He emphasized the "all" by indicating that there still are too many people who have their "favorite" airplanes on which they spend the major portion of their sales effort to the detriment of other models. And he also emphasized that to increase sales will mean that there will have to be "more of you—more salesmen and more dealers."

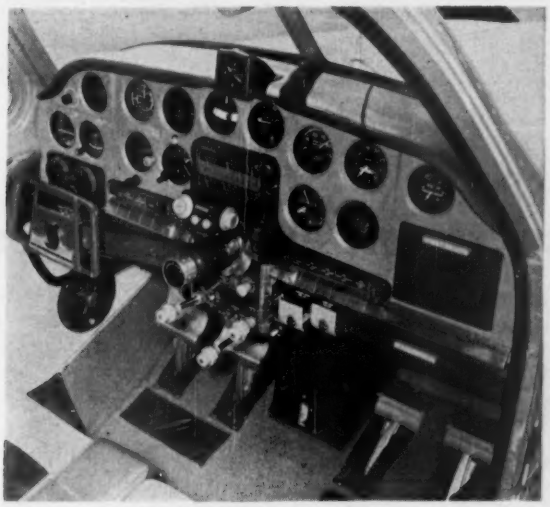
Greever's optimism that Beech would meet the goal of $60 million in 1960 seems to rest on solid ground—although in the final analysis it will be the field sales force that will provide the payoff. There are these factors in favor of the company's distributor-dealer organization this coming year to a greater extent than ever before:

- **Low inventories** of 1959 models, which give the dealers a good start on promoting the 1960 models. Bonanza inventories, for example, are less than half of what they were a year ago, Greever noted. Super 18 inventories are almost gone, he said.
- **More than 25%** of the company's present record-breaking backlog of more than $24 million worth of new airplanes ordered by dealers has already been sold to customers sight unseen. Beech this year, with the inventory situation looking favorable, held a meeting last August with top distributors and dealers to brief them in advance of the annual sales meeting so they were able to start their sales campaigns early and tap many prospects who might have bought competitive makes in the interim.
- **Major improvements** in its models, in response to dealer requests, should en-

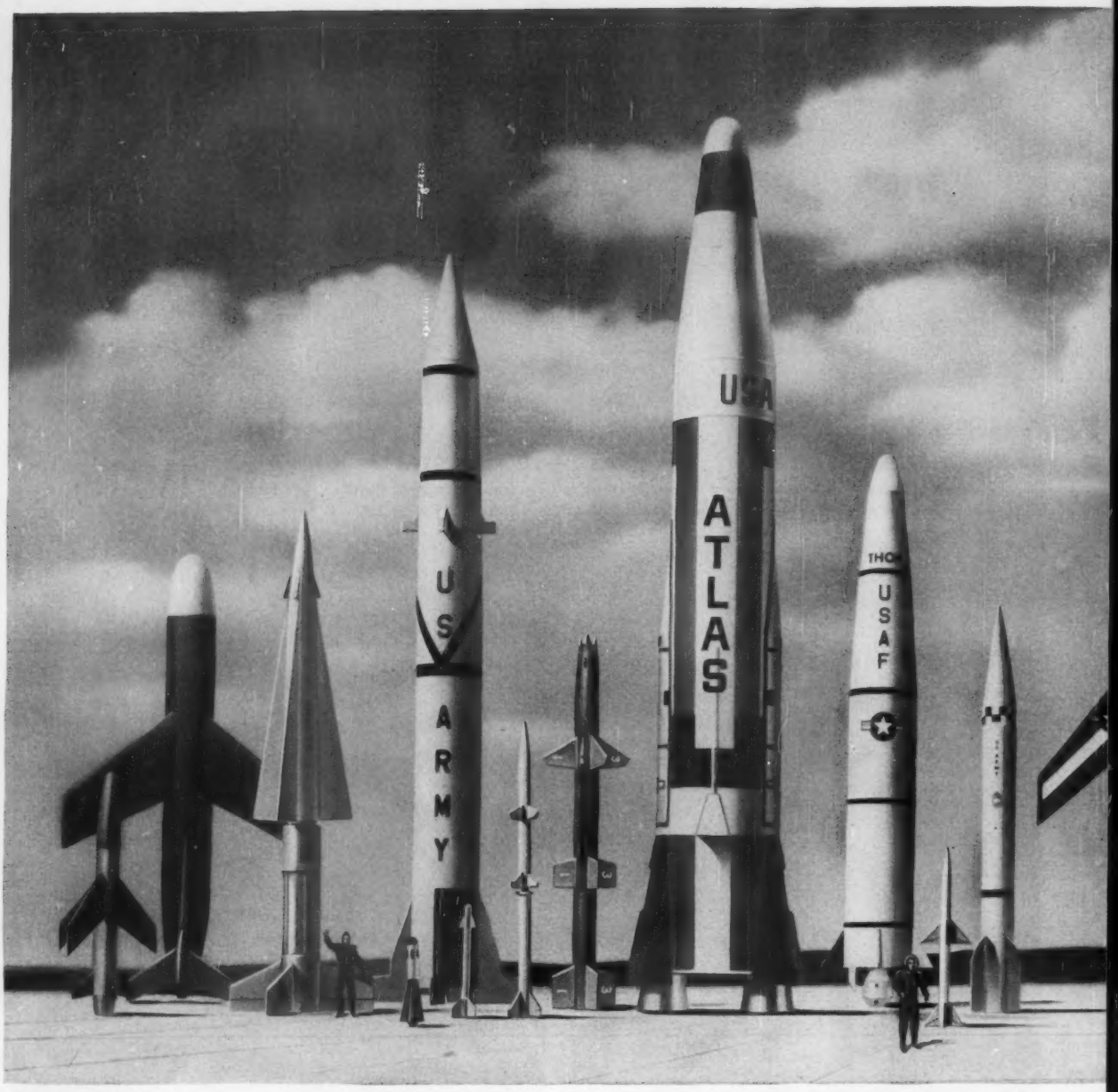


TRACK-MOUNTED seats on Beech Twin-Bonanza (left) are a sales feature this year; rearward view shows baggage stowage area. View of plane's airstair door is at right; its use obviates the need for climbing on wing and over seats, as in past years.

LARGER tail on 1960 Beech B95 Travel Air takes care of center of gravity travel brought about by lengthening the cabin. Seats are track-mounted and backs can be lowered to provide beds. Electrical panel is at left side of cockpit, providing more panel room.

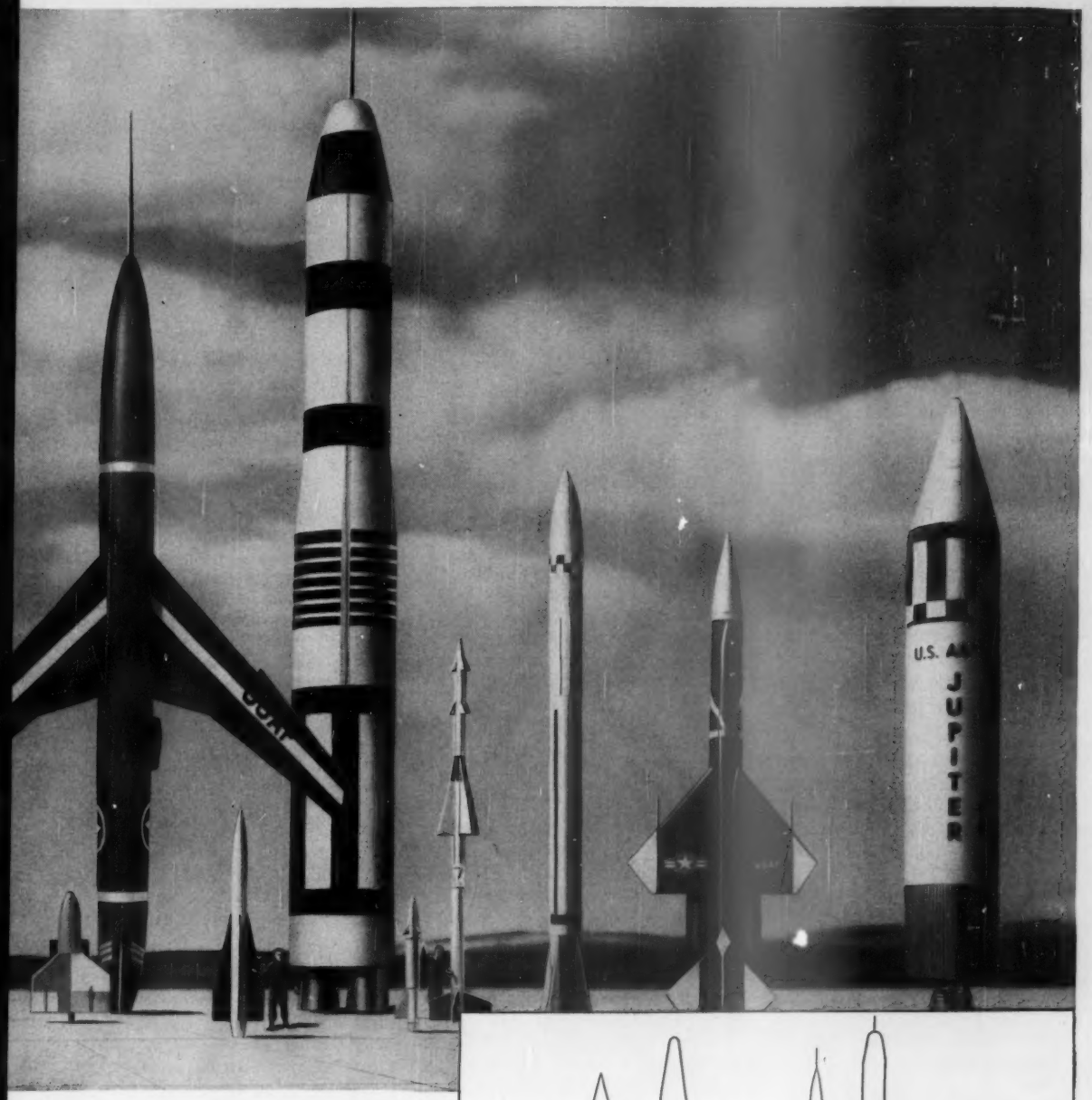


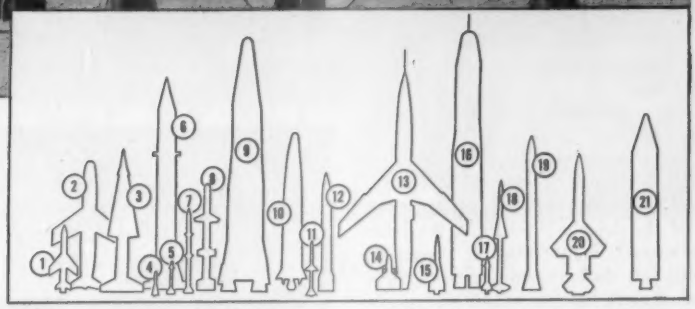
REVISED instrument panel in the Beech M35 is shown at the left; auxiliary fuel switch has been relocated to the center, near the throttle. Square wingtips keynote the M35. Primarily a style change, the tips improve aerodynamic flow.



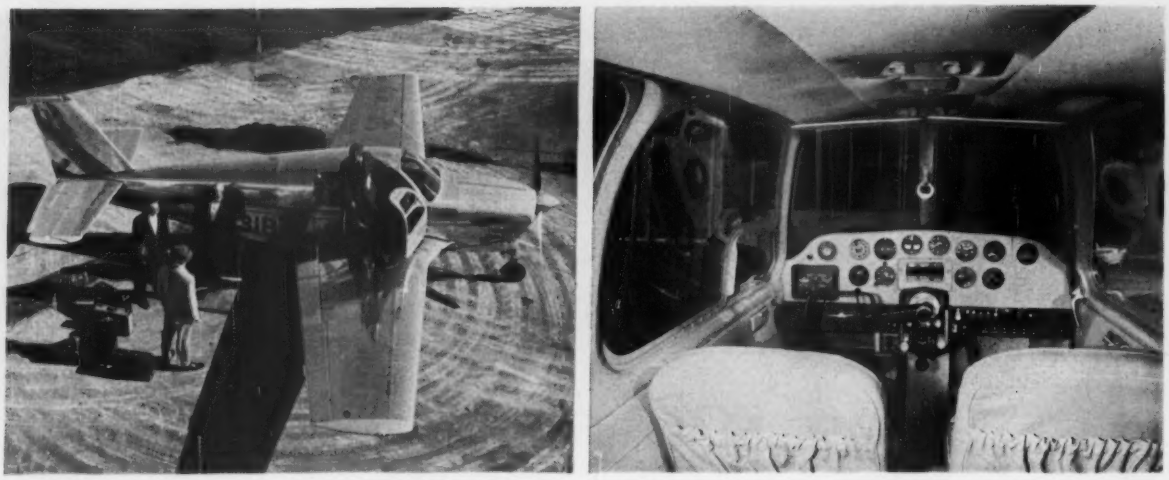
21 U.S. missiles rely on Raytheon electron tubes

RAYTHEON COMPANY, WALTHAM, MASS. RAYTHEON *EXCELLENCE IN ELECTRONICS*





1. **Lacrosse.** Army. Ground-to-ground. Prime contractor: Martin.
2. **Mace.** Air Force. Ground-to-ground. Prime contractor: Martin.
3. **Nike Hercules.** Army. Ground-to-air. Prime contractor: Western Electric.
4. **Falcon.** Air Force. Air-to-air. Prime contractor: Hughes.
5. **Sidewinder (GAR-8).** Navy/Air Force. Air-to-air. Prime contractors: Philco; General Electric.
6. **Redstone.** Army. Ground-to-ground. Prime contractor: Chrysler Corp.
7. **Terrier.** Navy. Surface-to-air. Prime contractor: Convair.
8. **Talos.** Navy. Surface-to-air. Prime contractor: Bendix Aviation.
9. **Atlas.** Air Force. Ground-to-ground. Prime contractor: Convair.
10. **Thor.** Air Force. Ground-to-ground. Prime contractor: Douglas.
11. **Sparrow III.** Navy. Air-to-air. Prime contractor: Raytheon.
12. **Sergeant.** Army. Ground-to-ground. Prime contractor: Sperry Rand.
13. **Snark.** Air Force. Ground-to-ground. Prime contractor: Northrop.
14. **Quail.** Air Force. Air-to-ground. Prime contractor: McDonnell.
15. **Hawk.** Army. Ground-to-air. Prime contractor: Raytheon.
16. **Titan.** Air Force. Ground-to-ground. Prime contractor: Martin.
17. **Bullpup.** Navy. Air-to-ground. Prime contractor: Martin.
18. **Nike Ajax.** Army. Ground-to-air. Prime contractor: Western Electric.
19. **Corporal.** Army. Ground-to-ground. Prime contractors: Firestone; Gilfillan.
20. **Bomarc.** Air Force. Ground-to-air. Prime contractor: Boeing.
21. **Jupiter.** Army. Ground-to-ground. Prime contractor. Chrysler Corp.



DEBONAIR four-seater, priced at $19,995, will put Beech into a market held by Piper with the Comanche and Cessna with the Model 210. Company cut Debonair costs with a simplified interior and instrumentation (right).

able the sales force to overcome objections that they said had lost them sales in the past. New Twin-Bonanzas, for example, this year have an integral airstair door providing easy access to the cabin and individual track-mounted chairs. The company is holding the 1959 price on several important models, such as the Bonanza and Travel Air, even with the addition of considerable improvements.

• **Larger model line** in 1960 adds the new medium-twin Queen Air between the Super G18 and the Travel Air, and the four-place Debonair at the lower-price end of the scale for those who did not feel ready to step up to the Bonanza price range just yet, making it possible for the organization to tap wider markets than ever before.

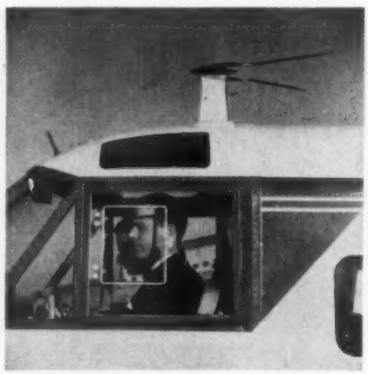
But, factory spokesmen quickly pointed out, these plus-factors hardly mean that the distributors and dealers only have to order airplanes and sit back expecting them to sell themselves. Competition from Cessna and Piper is going to be heavier than ever before (AW Nov. 2, p. 108; Nov. 9, p. 118), with all companies setting high sales goals, expanding sales outlets and offering larger model lines. This competition has already made itself felt on the sales charts; as Greever pointed out, in the decade 1950-1959, the business aircraft manufacturing industry's volume has shot up some 676%, while Beech growth has been 600%.

In discussing the growth in business volumes available to the distributors, Greever noted that in 1959 the company granted over $8.6 million in discounts to domestic outlets, compared with just over $2 million in 1953 and just over $5 million in 1955. In the 1949-1959 period, Beech discounts to distributors have increased some 800%, he noted, while the company's total business has increased some 600%. In 1959, discounts to domestic distributors included approximately $3.1 million on the Bonanza, $1.5 million on the Travel Air, $1.3 million on the Twin-Bonanza and approximately $2.5 million on the Super 18. And on the basis of distributor-dealer financial statements, these sales and service outlets realized better than 6½% profit after taxes, with a net of better than 22% before taxes, based on gross business including sales of airplanes, parts, service, fuel and all other income.

Financial Statements

Importance of the distributor-dealer's financial statement was underscored by A. R. Bell, who heads up Beech Acceptance Corp., the company's wholly-owned financing organization. He told the listeners that their monthly financial statement was one of the most important things they had for planning their future, because it spotlights a business' good and bad points.

Holding up five financial statements from Beech distributors, he noted that only two of them showed that these outlets were making money in all departments and not as much as they could or should.



LARGE side window and two-piece windshield mark the 1960 Super G18. Side window incorporates a large storm panel.

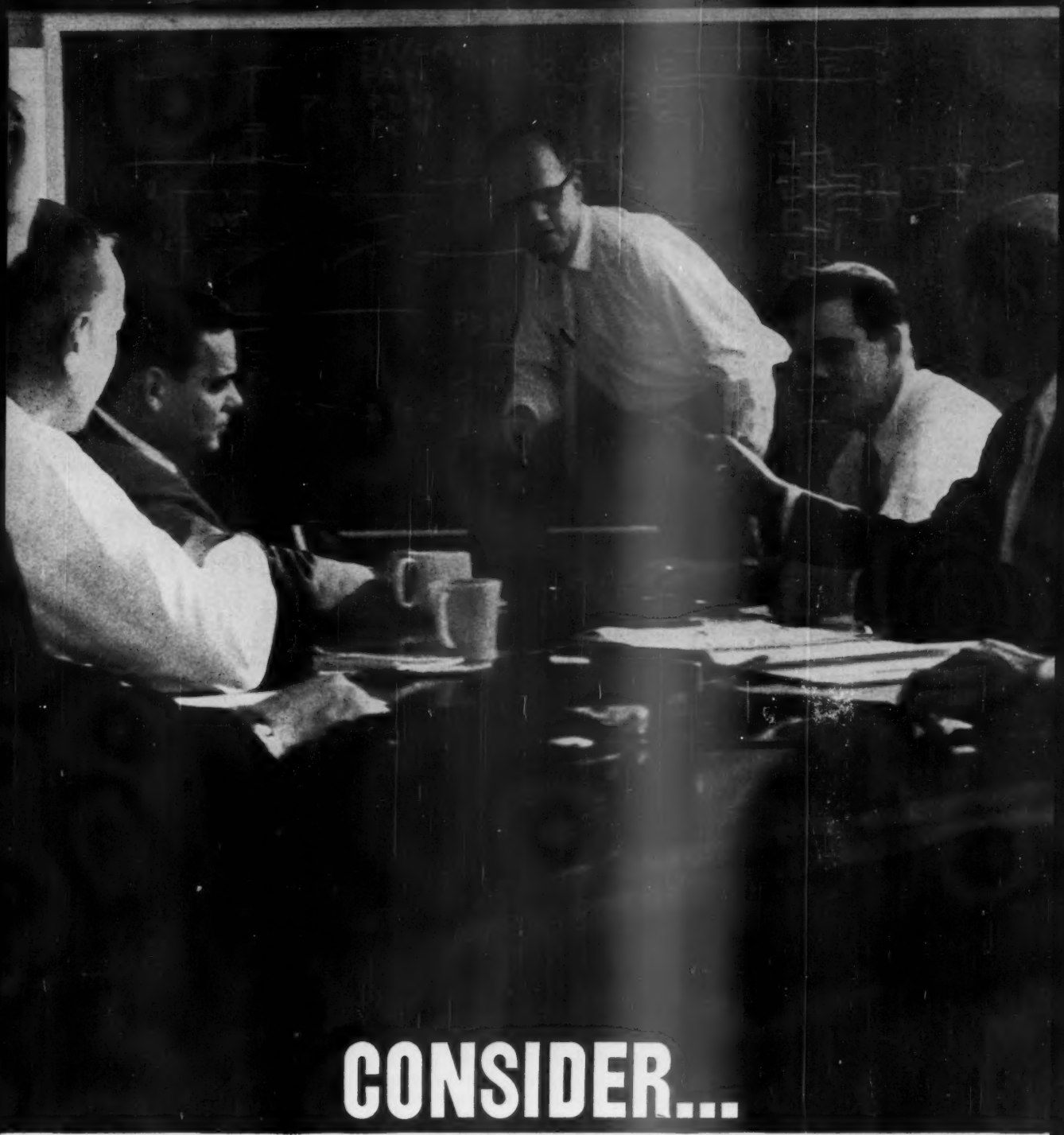
A detailed statement may tell the distributor that he is losing money in his service department—but not why. This takes sound expense control, especially on fixed expenses, which are not easy to manage. He pointed out that personnel absorb some 80-85% of fixed expenses, so the distributor and dealer have to keep track of how these people are being used, how they are being managed and how they buy. Good organization is needed to make sure that high-priced mechanics are not doing line or porter work, he emphasized.

Marketing Service Manager Paul Allen pointed out that a lot of money is being lost by sales outlets in the way they handle spare parts orders. In Fiscal 1959, Beech delivered some $4.9 million worth of spares to domestic and export distributors, yet only 27% made their purchases on a monthly stock order, which provides them with an extra 5% commission.

Briefing the sales representatives on financing, Bell noted that in his opinion money is about at the peak of its tightness and that interest rates will stay about where they are now for a long period.

Banks, he contended will not seek too many new customers on loans and many will probably seek to keep down their aircraft loan operations.

He pointed out that in making a sales contact, the Beech representative should get into the lease and finance aspects of procuring an airplane to the customer in his initial discussion. Many companies already are aware of equipment leasing, he noted—some 7½% of truck registrations in this country are on a lease basis, and automobile registrations are higher—and customers will be receptive to discussing aircraft equip-



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ment procurement on this basis.

He particularly cautioned salesmen against farming out airplane financing. Any outside interest may cause the sale to be lost—banks, he said, may discourage the customer from extending his loan credit by buying a plane.

Beech Acceptance Corp. has financed nearly $40.5 million worth of business aircraft, numbering 1,145 units, since it started operation in 1956, Bell reported. These included 295 airplanes financed on retail loans, 110 on lease deals and 740 floor-planned to enable sales outlets to maintain demonstrator lines.

Additional aids for the company's field force will include the new national accounts representative, Tom Gillespie, who will work out of the factory with field salesmen in aiding them to close sales to large fleet operators. Gillespie has made a detailed study of some 35 large business aircraft fleet operations: type of planes they buy, where they buy them, how planes are scheduled, how spares and maintenance are handled, operating and fixed and variable costs to provide necessary background on what information is needed to close the sale with a big operator. Gillespie will be on call by distributor-dealers when they need expert advice on doing transportation analyses for this market.

The company is also providing specialized consulting for distributors and dealers who are thinking about expansion programs, to help them in developing best layout, architectural design and optimum efficiencies in use of space.

Aircraft Line

The company's 1960 business aircraft line is the largest it has ever had available, with seven versions of six distinct types. Highlights of the 1960 lineup are:

• **Twin-Bonanza** is available in two models, the H50, which has 340-hp. fuel-injection supercharged Lycoming IGSO-480-A1A6 engines and sells at a basic consumer list price of $95,500; the D50C, which has the high-compression 295-hp. Lycoming GO-480-G2D6 engines and lists at $83,000. Except for powerplants and performance, the airplanes are similar; both feature the new integral airstair door on the right side just behind the wing root permitting direct entry to the cabin, and individual track-mounted chairs which provide a center aisle for easy access to various seats. Beech has dropped the floor of these airplanes approximately four inches, providing considerably more head room. Backs of standard lightweight chairs can be lowered to provide sleeper seats, or a new lightweight couch can be installed, providing seven places. Couch can be removed or installed in approximately three minutes. Other improvements include a new pilot's seat with vertical adjustment, flush-type fuel tank vents under the wings for better icing control, dual fuel pumps on the cabin heater system to increase its efficiency, squared wingtips providing improved tip efficiencies and improving low-speed characteristics, and addition of the new lightweight Goodrich de-icer boots, which are approximately 65 lb. lighter than previous models. Gross weight of the H50 has been increased from 7,150 lb. to 7,300 lb. at a 40-lb. increase in empty weight, giving the airplane a useful load of 2,200 lb. Bill Quinby, new Twin-Bonanza sales manager, replacing Tom Gillespie, said he believes there is a national potential of 143 Twin-Bonanzas in 1960, compared with 129 in 1959.

• **Travel Air B95,** light-twin four-five seater, will list at $51,500 in its basic configuration, same as the 1959 model, in spite of considerable improvement in the cabin area which provides an additional 19 in. of rear cabin space for a gain of 17 cu. ft., giving ample room for a fifth seat. Seats are also track-mounted and have fully reclining backs. Front seat is raised to improve visibility. Instrument panel has been revised; by putting electrical switches on a separate panel on the left side of the cockpit, sufficient room has been gained to permit mounting four instruments in a row for improved grouping and there is also more room for radio. Major aerodynamic changes are a redesigned tail group adding 19-in. span to the horizontal surfaces and a new semi-swept, cleaner vertical stabilizer with improved fairing on the dorsal fin. New tail improves center-of-gravity loading of the airplane and also takes out the earlier models' nose-heavy feeling. New wing flaps, some 4½ in. wider than the pre-

Bonanza Capability

Wichita, Kan.—Nonstop delivery flight of 1,275 mi. in 6 hr. 20 min. by a 1960 Beech M35 Bonanza from the factory to the West Coast after the close of an annual sales meeting here points up the performance of modern single-engine business aircraft.

Charles F. (Chuck) Amos, Aero Sales & Service, Inc., Fresno, Calif., a dealer for distributor Norman Larson, Van Nuys, made the flight at 12,500-ft. altitude using 53% power of the 250-hp. Continental IO-470-C fuel injection engine at 2,300 rpm. and 18 in. manifold pressure, which gave him a fuel consumption of 9.5 gph. for the trip. His block-to-block ground speed averaged 201 mph.; true air speed at 12,500 ft. varied from 198 to 204 mph.

BIG news in electronics for vibration testing

One of the world's largest vibration test systems was recently shipped by MB to the Sperry Gyroscope Company. It featured an electrodynamic exciter of 25,000 pounds force output, a 100 KW high fidelity power amplifier of advanced design, and fully integrated, electronic controls for complex motion tests.

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- first use of active analog computers
- first application of XY recording technique
- first to achieve low distortion in big-output amplifiers
- first displacement limiter providing protection without complete system shutdown
- first use of high-degree negative feedback around output tubes
- first use of regulated tube filaments

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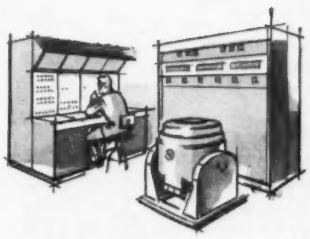

Pioneer and leader in the field of vibration

TWENTY million watts—that's the cumulative output available from MB power supplies now driving vibration test systems in the field.

The figure is more than a measure of the new importance of vibration testing. It's a measure of MB's technical advancement in the field of electronics for vibration, acoustics, and sonar.

And it's a measure of the company's unequalled background of experience in designing electronic power for dynamic forces . . . in producing *integrated* vibration testing systems including amplifiers of 100KW output and more, and exciters that utilize amplifier power more efficiently . . . in programming vibration tests to any required specification. This experience is available to you through MB's staff of vibration specialists and the largest force of field service technicians. Avail yourself of their expert recommendations on your vibration test problems.

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Civil Aircraft, Engine Shipments

Shipments by Plants Manufacturing Complete Civilian Aircraft and Engines for Civilian Aircraft

Item		1959 September	Totals Jan.–Sept. 1959
Complete aircraft, total airframe weight	(add 000 lb.)	1,772.1	16,043.5
By weight of plane:			
Under 3,000 lb. airframe weight	do	419.1	5,858.9
3,000 lb. airframe weight and over	do	1,353.0	10,184.6
By number of places:			
1- and 2-place	do	382.1	5,412.6
3- and 5-place	do		
Over 5-place	do	1,390.0	10,630.9
By total rated horsepower, all engines:			
Under 100 hp	do	339.2	5,004.8
100-399 hp	do		
400 hp. and over	do	1,432.9	11,038.7
Aircraft engines:			
Reciprocating	Number	804	7,990
Gas turbine	do	(D)	(D)
Aircraft engines, total horsepower:			
Reciprocating	(add 000 hp)	168.9	1,680.5
Gas turbine	do	(D)	(D)
Complete aircraft	Number	432	6,012
By weight of plane:			
Under 3,000 lb. airframe weight	do	396	5,697
3,000 lb. airframe weight and over	do	36	315
By number of places:			
1- and 2-place	do	383	5,338
3- and 5-place	do		
Over 5-place	do	49	474
By total rated horsepower, all engines:			
Under 100 hp	do	361	5,329
100-399 hp	do		
400 hp. and over	do	71	683
Value of shipments of complete aircraft and parts, total	(add $000)	83,702	670,073
Aircraft, total	do	75,950	607,535
Under 3,000 lb. airframe weight	do	7,407	94,356
3,000 lb. airframe weight and over	do	68,543	513,179
Aircraft parts	do	7,752	62,538
Value of shipments of aircraft engines and parts, total	do	14,900	122,316
Aircraft engines:			
Reciprocating	do	2,237	21,629
Gas turbine	do	(D)	(D)
Engine parts	do	12,663	100,687
Unfilled orders (planes 3,000 lb. airframe weight and over)	Number	531	...

D = Withheld to avoid disclosing figures for individual companies. Data prepared by Bureau of the Census, Industry Division, Machinery & Equipment, received from 22 companies operating 22 plants producing complete aircraft and seven engine companies operating seven plants.

vious type, keep stall speed at 70 mph. Despite a gross weight increase of 100 lb., useful load is approximately 35 lb. higher. The airplane can take the new Goodrich boot de-icing system. Anti-icing fluid tank for propellers is located in nose baggage compartment.

• **Debonair Model 33** four-placer, which will sell for $19,995, is designed to compete with the Cessna 210 and Piper Comanche and is in the market area in which Beech sees a volume of some $53 million over the next two years for this class airplane. Primarily a Beech Bonanza airframe, the company has simplified the interior and equipment, put smaller wheels on the airplane and used the 225-hp. Continental IO-470-J fuel injection engine to get the price down. With this powerplant and a Hartzell constant-speed hydraulically-controlled propeller, the Debonair has a gross weight of 2,900 lb., useful load of 1,170 lb. and a high speed of 195 mph., with cruise speed being 185 mph. at 75% power at 7,000 ft. and 180 mph. at 65% at 11,000 ft. Service ceiling is 19,800 ft. Fuel capacity, standard tanks, is 49 gal., with auxiliary tanks giving 68 gal. usable fuel. Maximum range is 1,170 mi. compared with 845 mi. on standard tankage. Ranges are at 143 mph. (45% power) at 10,000 ft. Airplane can carry 270 lb. maximum baggage. Type certification was done in utility category.

• **Super G18,** which is the company's seven-to-nine-place "heavy twin," this year sells at a basic list price of $126,000, up $3,500 over the 1959 model. Major improvements have been in the cockpit area, a new two-piece windshield, split in the middle by a narrow center strip providing considerable increase in visibility. Extension of overhead canopy provides additional headroom. Rudder pedals are adjustable 2½ in. and a new control lock has been designed that can be engaged into the pedals from a standing position. Larger side windows include an openable storm panel; windows can be jettisoned for emergency exit. Instrument panel has been redesigned so that all radio switches are located across the top; the only overhead item being firing switches for Aerojet-General JATO rockets, which can be mounted in the rear of the engine nacelles as optional equipment. Another feature is exterior-mounted "ice lights" beamed along the leading edges of the wings. Oxygen bottles, formerly located behind number 5 bulkhead in the cabin, now are located in the lower nose on the left side for easier servicing.

Super 18 Sales Manager Guy Miller noted that 68 units were sold in 1959 at a total consumer list price of $10.6 million—Ohio Aviation Co., Vandalia, took delivery of 11 airplanes, the all-time record since the airplane was introduced. In all, nine distributors made

from 133⅓ to 200% over their quota on this airplane last year.

Miller cautioned distributors on taking on too much workload as regards radio installation on the Super 18, pointing out that the factory now has set up a custom radio shop that could free distributors of the need for tying up capital in such facilities, and also obviates the need for holding the airplane up for a month to six weeks after delivery to the distributor prior to handing it over to the customer fully equipped. He noted that one distributor he visited had some $220,000 worth of radio inventory. Under the new arrangement, the distributor commission on a factory-installed radio is 100% profit and he also gets a commission on the labor. Miller estimated that installation at the distributor's base "only provides a 6-7% profit."

• **Bonanza M35** this year is offered at the same $25,300 price as last year's K35—Beech skipped the letter "L" this year to avoid confusion with USAF-Army use of this suffix to denote liaison aircraft. Few major changes mark this four-placer, which is now in production for 13 years during which time 6,161 have been delivered. Square wingtips have been added and instrument markings, placards and decals are matte white for easier readability. Auxiliary fuel pump switch has been moved to the center of the instrument panel near the throttle. The company sold 413 K35 Bonazas last year, 33 more than the previous year in spite of a $1,000 price increase, Sales Manager Steve Howbert pointed out, with six of the company's distributors selling 30% of the total. Of every four Bonazas sold last year, one was equipped with the extra seat making it a five-placer.

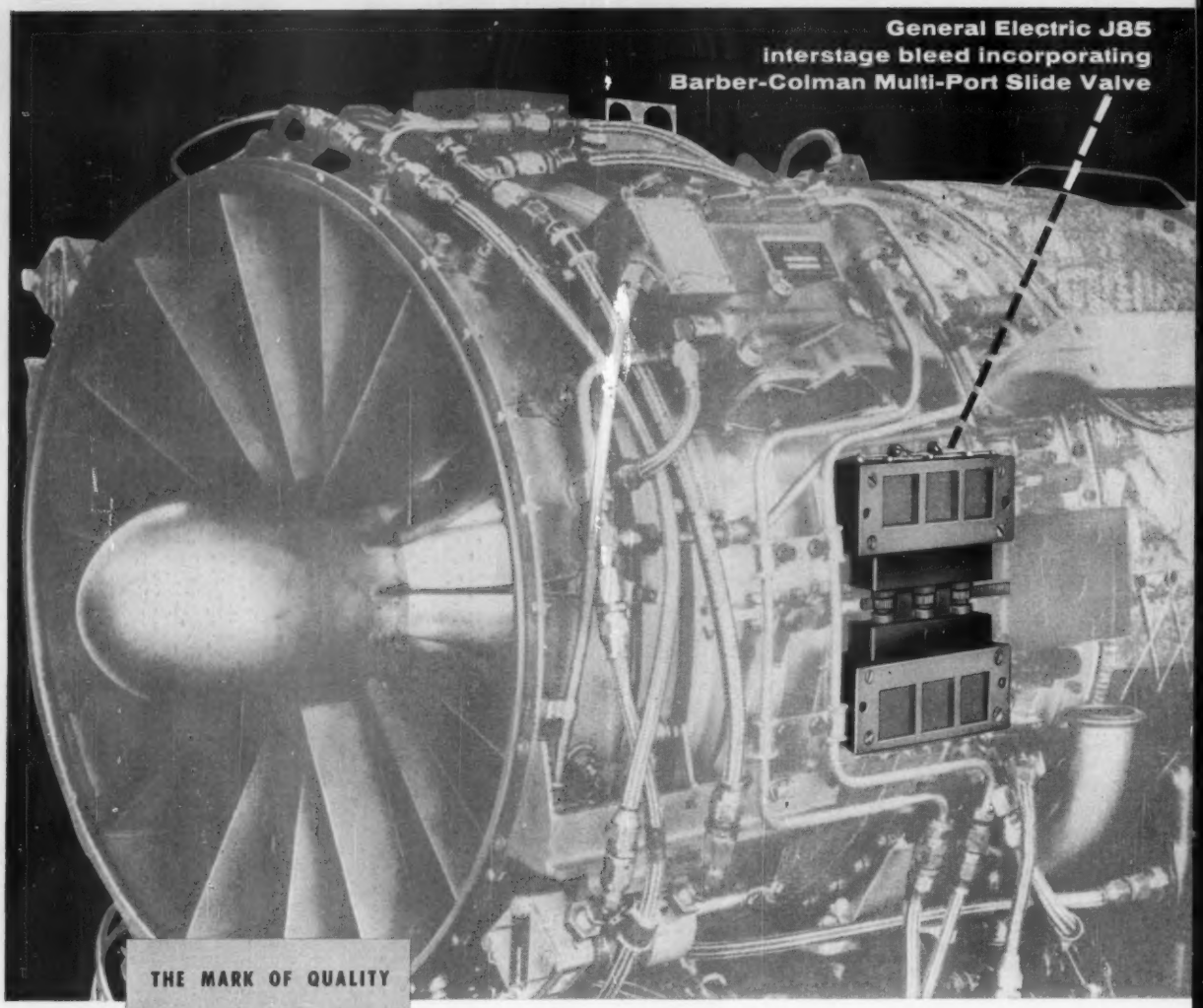
Sales Leaders

Honors were paid to the company's distributors and dealers making high sales scores last year. Named for outstanding performance on all four models were Cutter-Carr Flying Service, Albuquerque, N. M., and Lang Aircraft, Omaha, Neb.

Cited for quota achievements for three models were: Jack Adams Aircraft Sales, Memphis, Tenn., Alamo Aviation, San Antonio, Tex., Atlantic Aviation New York Division, Teterboro, N. J., Atlantic Aviation-Wilmington Division, Del., Combs Aircraft, Denver, Colo., Elliott Flying Service, Davenport, Iowa, Ohio Aviation, Vandalia, Topeka Aircraft Sales & Service, Kan., Tulsair Distributors, Tulsa, Okla., and Roscoe Turner Aeronautical Corp., Indianapolis, Ind.

Eighteen domestic distributors joined the Beech Million Dollar Club: Alamo Aviation, Atlantic Aviation-New York, Atlantic Aviation Service, Philadelphia, Pa., Butler Airplane Sales, Rockford,

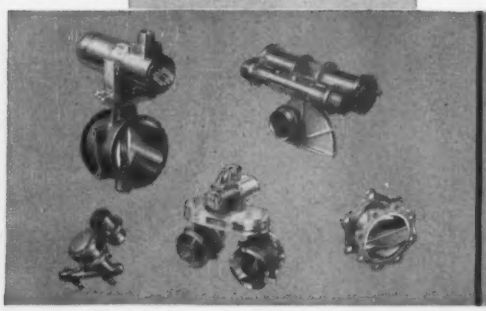
Statham
Deep in the heart of nearly every ballistic missile in the nation's space-age arsenal is the Statham transducer. Of more than 40,000 parts in a missile, none is more vital than its transducing elements. Without them, it would be difficult if not impossible to determine component reliability or to record the functional performance of the missile in space.
Typical of these rugged instruments is Statham's new 250-millivolt high output pressure transducer that permits direct connection or commutation to low level voltage-controlled oscillators. This ¼-volt series, designed for sophisticated instrumentation, is fully described in Data File AW-909-1.
For leadership in measurement
STATHAM INSTRUMENTS, INC.
12401 W. Olympic Blvd.
Los Angeles 64, California

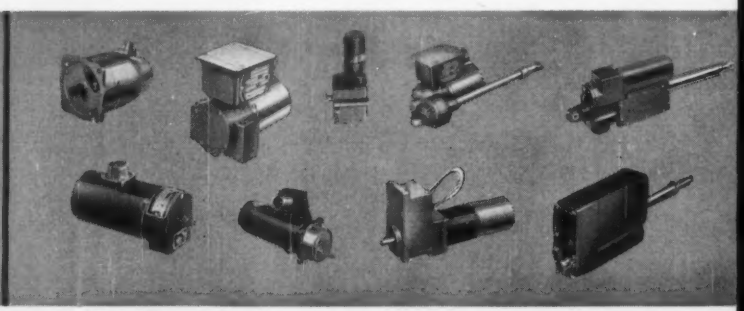


THE MARK OF QUALITY

BARBER COLMAN

Aircraft and





AIR VALVES — A wide variety of electrically and pneumatically operated air valves for temperature and pressure-control applications. Butterfly, check, poppet, slide, and automatic drain types.

ACTUATORS — Rotary and linear types featuring a wide range of gear reductions, switching and mounting details. Available either as standard units or special designs to fit various applications. Designed to applicable military specifications.

New Barber-Colman Multi-Port Slide Valves developed for General Electric to help give the J85 high performance and efficiency over a wide operating range

In addition to its compact size and light weight, General Electric's new J85 turbojet features high performance and high efficiency over a wide range of operating speeds. Barber-Colman, working with General Electric engineers, developed a unique multi-port slide valve to meet special performance and package requirements. This valve, shown at the left, plays a vital part in the high efficiency of this engine.

Manufactured exclusively by Barber-Colman Company, these valves are made in four-port and six-port types for use in J85 turbojets which will power many of the nation's most advanced piloted aircraft, missiles, and drones. J85 applications include the Northrop T-38 "Talon," and N-156F "Freedom Fighter," the McDonnell GAM-72 decoy missile, and the Radioplane Q-4B target drone.

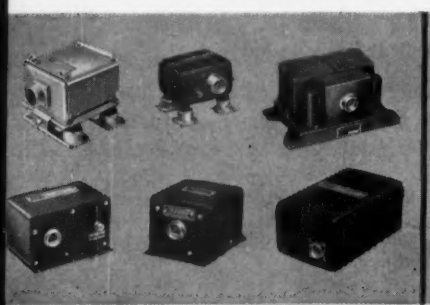
Characteristics of Barber-Colman multi-port slide valves are as follows: Maximum temperature — 630°F. Maximum pressure — 60 psig at 630°F. Ambient temperature — 65°F to 350°F. Total leakage — 1.55 lb/min at 60 psig and 630°F.

This valve story illustrates the typical way Barber-Colman works with leaders of the aircraft and missile industry to apply our specialized know-how to major industry projects. Consult the engineering sales office nearest you: Baltimore, Boston, Fort Worth, Los Angeles, Montreal, New York, Rockford, Seattle.

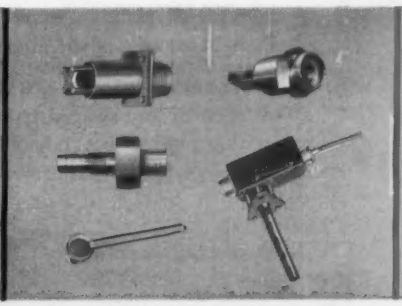
BARBER-COLMAN COMPANY

Dept. X, 1422 Rock St., Rockford, Illinois

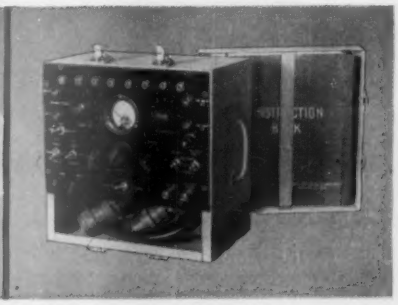
Missile Accessories



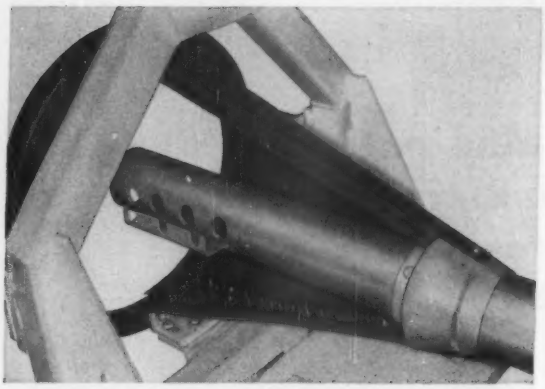
TEMPERATURE CONTROL AND POSITIONING SYSTEMS — Electronic, magnetic amplifier, transistor, or relay-controlled systems designed to meet your requirements.



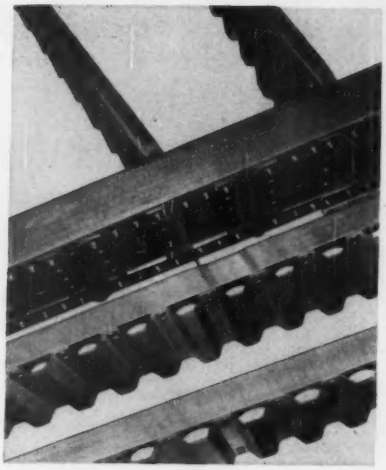
TRANSDUCERS AND THERMOSTATS — Units for sensing compartment, duct, windshield temperatures. CEDAC system senses, controls temperature and/or airflow in ducts.



TEST EQUIPMENT — Compact electrical test units for quickly checking all components of a Barber-Colman control system installed in an aircraft. Special units for checking many electrical systems.

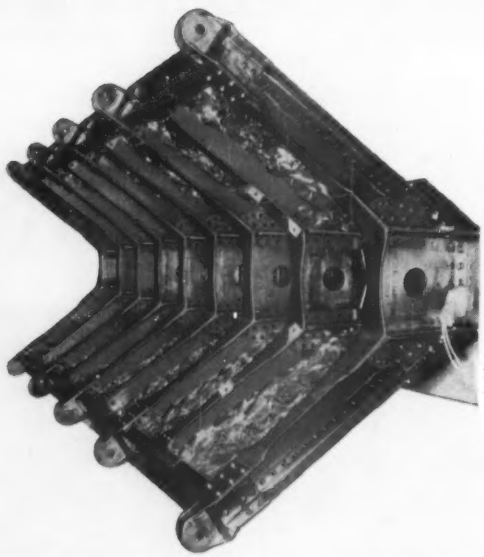


NOSE CONE SPLICE JOINTS ARE FASTENED WITH HS67 PINS, TYPE 431 STAINLESS STEEL, HEAT TREATED TO 125,000 PSI MINIMUM SHEAR. THE HS60M COLLARS ARE R MONEL.



WING SPARS, FRONT AND REAR, HAVE SPAR CAPS ATTACHED TO WEB SECTIONS WITH HS92 PINS, A286 ALLOY, HEAT TREATED TO 95,000 PSI MINIMUM SHEAR HS60M COLLARS ARE USED.

*X-15 .. A CHALLENGE FOR FASTENERS



WING ATTACH STRUCTURE IS ASSEMBLED WITH INTERFERENCE FIT HI-SHEAR RIVETS. THE HS128 PINS ARE 17-4PH STAINLESS STEEL, HEAT TREATED TO 120,000 PSI MINIMUM SHEAR. THE HS91 AND HS92 PINS ARE A-286 ALLOY, HEAT TREATED TO 95,000 PSI MINIMUM SHEAR. BOTH PINS USE HS60M R MONEL COLLARS.

The X-15 research vehicle... ready for the first manned probe into space... with speeds exceeding 3600 mph... for altitudes above 100 miles... to withstand 1200°F... a challenge for fastening techniques.

The selection of the Hi-Shear rivet for use in the X-15 is an outstanding example of how this and other high strength fasteners are being developed at Hi-Shear research facilities to keep pace with the ever changing requirements of the aircraft and missile industries.

The Hi-Shear rivet *still* offers the *lightest strength-weight ratio* of any swaged type fastener, simplicity of installation and service reliability established by sixteen years acceptance by industry.

Contact your Engineering Standards Group or write to us for specific fastener data.

*"HI-SHEAR" TRADEMARK REGISTERED U.S. PAT. OFFICE. U.S. PATENTS 2,355,579; 2,355,580; D-138,579; OTHER U.S. AND FOREIGN PATENTS PENDING.

hi-shear **RIVET TOOL COMPANY**

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Ill., Combs Aircraft, Cutter-Carr Flying Service, Elliott Flying Service, Fransic Aviation, Lansing, Mich., Gopher Aviation, Vandalia, Ohio, Tulsair Distributors, Roscoe Turner Aeronautical Corp., and Youngstown Airways, Ohio. Two export distributors having attained $1 million in sales last year are: William C. Morales & Co., S. A., Caracas, Venezuela, and Will L. Smith, S. A., Buenos Aires, Argentina.

Named outstanding dealers were Central Flying Service, Little Rock, Ark., Wathan Flying Service, Cedar Rapids, Iowa, Aero Sales & Service, Fresno, Calif., Baton Rouge Aircraft, La., Linden Flight Service, Linden, N. J., and George H. Bailey Co., Ft. Wayne, Ind.

PRIVATE LINES

Brochure on Lockheed Aircraft Service's conversion of Douglas B-26 to pressurized version for business flying is available from LAS, care of general sales manager, Ontario, Calif. The B-26 will seat 10 and provide cabin pressure equivalent to 8,000-ft.-altitude at 20,000 ft. Normal range is 2,500 mi.

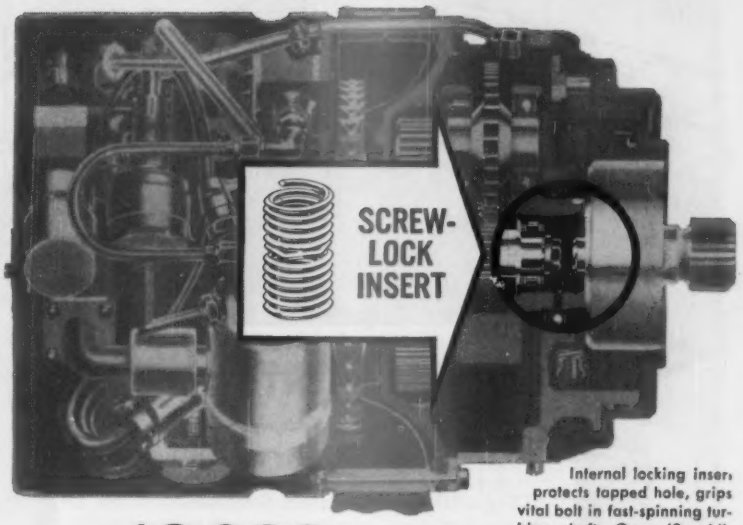
Italian Aeronautic Register reports that as of Aug. 31 there were 901 private planes registered in Italy. Of these, 469 belong to the government, 170 to clubs, 69 to various transportation companies, 45 to Alitalia and 28 to aircraft manufacturers.

Two Convair 440s owned by General Motors will be refitted to custom executive interiors by AiResearch Aviation Service Division of the Garrett Corp. Job also includes auxiliary fuel tanks and exterior painting.

University of California agronomist Milton D. Miller estimates that 15% of the state's three million acres of grain and hay crops now are sown by aircraft. California farmers have hired 221 firms flying 1,389 planes to do the job.

Brantley B-2 helicopter will be distributed in Michigan, northern Indiana, northwestern Ohio and northern Illinois by Aero Enterprises, Inc., Midway Airport, Elkhart, Ind. M. L. Alson, Aero president, said the firm has sold two B-2s and has orders for another three. One B-2 is available for demonstration.

Butler Aviation has acquired Skymotive, Inc., based at Chicago's O'Hare Field, and will operate the company as a subsidiary. Skymotive, an FAA-approved repair station, becomes Butler's 10th fixed base operation.



Internal locking insert protects tapped hole, grips vital bolt in fast-spinning turbine shaft. Over 40 additional *Heli-Coil* Inserts insure threaded fastener security throughout the starter.

at 46,000 R.P.M.

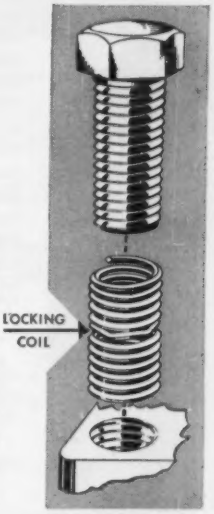
HELI-COIL®

SCREW-LOCK INSERT*

holds this vital bolt fast
...Without Lock Washers
or Lock Wiring!

Even when the turbine shaft of General Electric's new AS-18 turbostarter whirls at 46,000 rpm ... the key bolt at the end of the shaft can't work or wear loose. General Electric puts a one-piece, *internal locking* Heli-Coil Screw-Lock Insert in this tapped hole, gets thread security in this important threaded assembly despite vibration met at high shaft speeds.

In addition to the critical shaft application, General Electric uses more than 40 of these *Heli-Coil* stainless steel wire inserts throughout this compact 165 hp starter for aircraft gas turbines. Production and performance benefits? Unshakeable fastener security *without* the use of clumsy, heavy lock nuts, lock washers and lock wiring ... lighter weight ... less installation cost ... faster and easier assembly and disassembly of this tiny power pack that weighs only 46 pounds! *Patented



Principle of *Heli-Coil* Screw-Lock Insert. Locking center coil grips screw in tapped hole; holds screw firmly against vibration and impact.

***Heli-Coil* Screw-Lock Inserts**

- positively lock screws and bolts against loosening under impact and vibration
- prevent thread wear, stripping, corrosion, galling and seizing
- eliminate lock nuts, lock wiring, other supplementary locking devices
- can be used in standard proportion bosses without need for redesign
- are available in a complete range of U.N.C. and U.N.F. thread sizes
- save assembly time, space, weight and cost
- meet military specs for locking torque and vibration

HELI-COIL CORPORATION
DANBURY, CONNECTICUT

HELI-COIL CORPORATION, 212 Shelter Rock Lane, Danbury, Connecticut
Send complete design data on *Heli-Coil* Screw-Lock Inserts

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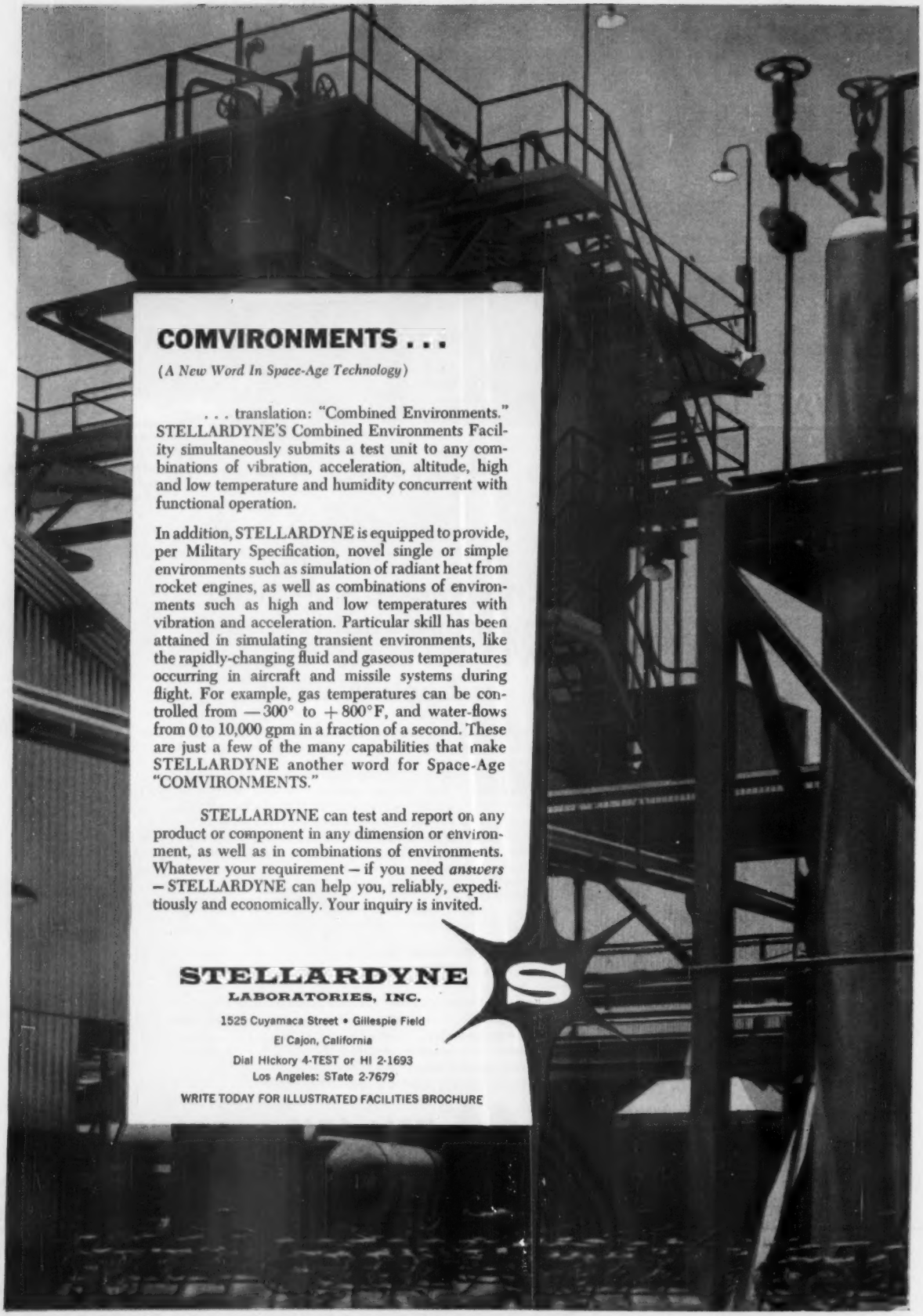
FIRM _____
ADDRESS _____
CITY _____ ZONE ____ STATE _____ 1772



COMVIRONMENTS . . .

(A New Word In Space-Age Technology)

. . . translation: "Combined Environments." STELLARDYNE'S Combined Environments Facility simultaneously submits a test unit to any combinations of vibration, acceleration, altitude, high and low temperature and humidity concurrent with functional operation.

In addition, STELLARDYNE is equipped to provide, per Military Specification, novel single or simple environments such as simulation of radiant heat from rocket engines, as well as combinations of environments such as high and low temperatures with vibration and acceleration. Particular skill has been attained in simulating transient environments, like the rapidly-changing fluid and gaseous temperatures occurring in aircraft and missile systems during flight. For example, gas temperatures can be controlled from $-300°$ to $+800°$F, and water-flows from 0 to 10,000 gpm in a fraction of a second. These are just a few of the many capabilities that make STELLARDYNE another word for Space-Age "COMVIRONMENTS."

STELLARDYNE can test and report on any product or component in any dimension or environment, as well as in combinations of environments. Whatever your requirement – if you need *answers* – STELLARDYNE can help you, reliably, expeditiously and economically. Your inquiry is invited.

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AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Ampex Corp., Redwood City, Calif., two ea., video tape recorder/reproducers, (Ampex Model FR-700), (PR-C-003034), $150,570.

The Trustees of Princeton University, Princeton, N. J., installation of a helium recovery system, (PR 62642), $80,000.

Lycoming Division, The Avco Manufacturing Corp., T-53-L-5 shaft-turbine aircraft engines for use in HU-1B flight test program, (PR 47916(MIPR R59-14-TC-RE)), $524,968.

Redmount Engineering Co., Minneapolis, Minn., 186 ea., probes, temperature, type MA-1 in accordance with MIL-P25726A (USAF) dated July 17, 1957 and amendment No. 1 dated July 24, 1958, Aerno 60-1602 for use in F-105D, F-106A and F-106B aircraft, (PR EA-O-1610-6124), $41,505.

Pako Corp., Minneapolis, Minn., 77 ea., photographic print washers, SN/EH6740-243-3135-J360 and 31 ea., model 13 "Pakonomy" dryers, SN/EH6740-685-6453-J360 and related equipment and data for use as ground support equipment, (MIPR's R59/707/383-NSF, R59/719/383-NSF and R59/764/383-NSF), $38,329.

Agraflms, Inc., Athens, Ga., production of a 35 mm. Eastman color negative motion picture entitled, "Effective Briefing," project 19288, (PR EM-O-MP-6269), $38,160.

Jack & Heintz, Inc., Cleveland, Ohio, 45 ea., control panels, in accordance with Convair specification 8-06371, revision "D," Jack & Heintz P/N 50127-000, Aerno 42-0746 and data (component of generator system type MB-2), for F-102 aircraft, (PR SA-9-03C-8354), $27,153.

General Electric Co., Utica, N. Y., 85 ea., control indicators, FSC No. 1270-296-4750, contractor's P/N 7330110G1 applicable to MD-1A fire control system used on B-66 aircraft, (PR's WR-9-1270-1017 and amendment No. 1 and WR-9-1270-1042 and amendment No. 1), $97,048.

Hughes Aircraft Co., Culver City, Calif., 178 ea., controls, antenna, contractor's P/N 435-19-2001-1, spares for type E-4 fire control system for F-86 aircraft, (PR WR-9-1270-911), $88,502.

Convair Division, General Dynamics Corp., San Diego, Calif., service test models of an UHF data link antenna system, end use: F-106 aircraft, (PR EC-9-16A-4763), $196,168.

Goodyear Tire & Rubber Co., Akron, Ohio, 125 ea., brake assemblies for 5.00-5 main wheel, type III, Aerno 41-1001; 80 ea., wheel assemblies, main, 20.00-20, type III, Aerno 41-1178; 80 ea., broke assemblies for 20.00-20 wheel, main, type III, Aerno 41-1181 (installation for H-43B and C-130B aircraft), and data, (PR's EA-O-163-6082 and EA-O-1630-6037), $78,230.

McDonnell Aircraft Corp., St. Louis, Mo., flight test program for F-101B aircraft, (PR DG-O-01A-4030), $500,000.

Beckman/Berkeley Division, Beckman Instruments, Inc., Richmond, Calif., components of data processing systems and related spare parts kits and manuals, (PR A/B/C 003032), $27,928.

Eastern Air Lines, Inc., New York, extension of services for storage inspection and maintenance of group B parts for CRAF program—DC-7B type aircraft, (PR EM-9-S-6420), $36,620.

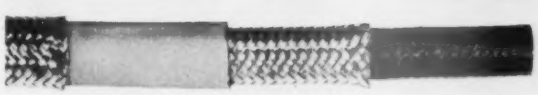
Utica Division, Curtiss-Wright Corp., Utica, Mich., facilities for the overhaul of the J-73 engine, (PR BI-9-F-9035, $240,-000.

Collins Radio Co., Cedar Rapids, Iowa, 167 ea., receivers, radio, type 51X-2B(108.0 to 151-95), Aerno 81-8090; 167 ea., instrumentation units, type 334B-1, Aerno 81-3353; 167 ea., controls, radio, type 624U-3A, Aerno 81-2332; 167 ea., mounts, shock, type 390E-1, Aerno 81-4482 and data (components of Collins Type VOR-101 navigation equipment, end use: T-37A modification), (PR MD-9-5821-36034 and amendment No. 1), $658,714.

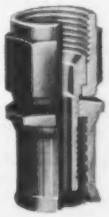
Radioplane Division, Northrop Corp., Van

Fluoroflex®-T *(Teflon®)* HOSE & ASSEMBLIES

engineered for SAFETY, RELIABILITY



HIGH PRESSURE, HIGH TEMPERATURE HOSE for service from −65° to +400°F. Dash 4 through −8 sizes in bulk or to specifications with swaged fittings qualified for 3000 psi systems.



MEDIUM PRESSURE, HIGH TEMPERATURE HOSE for up to 1500 psi service from −100° to +450°F. Dash 3 through −24Z sizes qualified to MIL-H-25579. Available with swaged type or Seal-Lock fittings.

FIREPROOF HOSE for dependable use in aircraft and engine fire zones. Complies with FAA fireproof requirements. Construction: Fluoroflex-T tube; AISI Type 304 stainless steel wire braid; specially impregnated asbestos shield, Dash 3 through -24Z with swaged type or Seal-Lock reusable fittings.

PROPELLER FEATHERING HOSE, for propeller control in aircraft fire zones. Complies with FAA requirements. Construction: Fluoroflex-T tube; AISI type 304 braid; two impregnated asbestos shields with intervening air spaces. Available with swaged or Seal-Lock fittings.

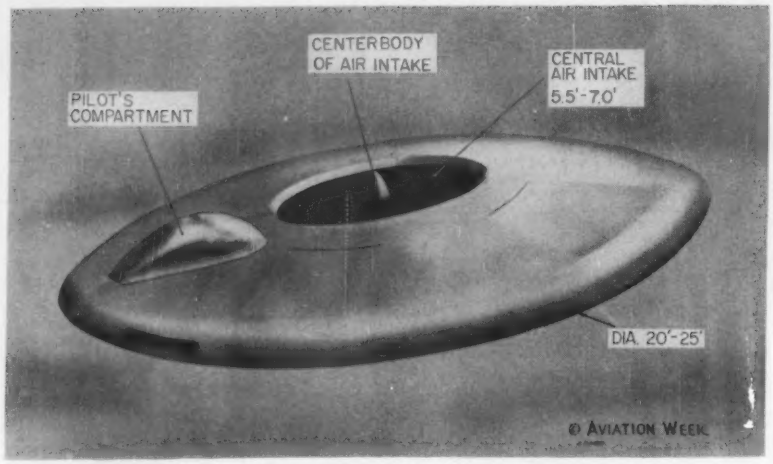
®Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.
®Teflon is DuPont's trademark for TFE fluorocarbon resins.

Originators of high temperature fluorocarbon hose assemblies

Resistoflex CORPORATION DEPT. 402

Offices in principal cities

Roseland, New Jersey • Western Plant: Burbank, Calif. • Southwestern Plant: Dallas, Texas.



Artist's Concept of Avro 'Saucer'

Aviation Week artist's conception of the external arrangement of the Avro "Saucer" aircraft (AW Nov. 9, p. 104) shows pilot sitting ahead of central intake for its three jet engines. The aircraft, funded by U. S. Air Force and Army, is designed to rise vertically—or almost vertically—using an annular jet of air that is exhausted around the perimeter of the circular airfoil. All "flight" tests of the aircraft thus far have been made in a tethered condition. First flight probably will be made around the first of the year. Leading edge of the aircraft is highly rounded, and its performance will be subsonic. Army views it as a possible replacement for current liaison aircraft with speed and good altitude capability. Supersonic models for the Air Force are planned with sharper leading edges.

Nuys, Calif., 1,057 ea., model OQ-19D aerial targets (including R196C/ARW 26 Y radio receiver selector) in accordance with contractor's report No. 495 dated May 15, 1959; 740 ea., OQ-19B aerial targets (less radio receiver selectors) in accordance with contractor's report No. 500 revised May 15, 1959; 740 ea., type R-196C/ARW-26Y radio receiver selectors, spare parts for Air Force Military Aid Program and Army, (PR's DQ-9-0-1550-4002 and amendments 1 and 2; MIPR's M01-021-36001-60 and amendment 1 and 2; %-02-090069-SC-01-23), $4,844,837.

Language Service Bureau, Inc., Washington, D. C., translation services, (PR C-092003), $90,000.

Defense Electronic Products, Radio Corporation of America, Camden, N. J., 115 ea., waveguide assemblies, Hughes Aircraft Co. P/N 435-16-001, FSN 1270-512-4977; 270 ea., blowers, Hughes Aircraft Co. P/N 435-68-001, FSN 1270-300-2556, for use as replenishment spares for E-4 fire control system for F-86 aircraft, (PR WR-9-1270-911), $54,977.

Instrument Division, McGraw-Edison Co., West Orange, N. J., 30,909 ea., bulbs, temperature, electrical resistance, type MS 28034-1, Aerno 61-8908; 7,120 ea., bulbs, temperature, electrical resistance, type MS 28034-2, Aerno 61-8909, for use on airborne aircraft accessory, IFB 33-600-60-11 (PR's MA-9-05D-1170 and EA-O-6685-6110), $100,-634.

Lansdale Tube Co. Division, Philco Corp., Lansdale, Pa., standardized indium anthimonide infrared detecting cell program, (PR MB-9-MMP-9156), $134,967.

The Magnavox Co., Fort Wayne, Ind., 1,967 ea., indicators, channel-frequency, ID-573/ARC, Aerno 81-3380; 1,904 ea., controls, radio set, C-1057B/ARC-34, Aerno 81-2333903 ea., controls, radio set, C-2006A/ARC-33 in accordance with Magnavox drawing No. 708325-1 and data, end use: F-101B, AMA class IV modified, (PR's SA-9-16A-7175; MO-9-MAINT-34750; MO-9-MAINT-34749; MO-9-MAINT-34792; MD-9-5821-26058; MD-9-5821-36046; MD-9-5821-36048; MD-9-5821-36036), $619,734.

Melpar, Inc., Falls Church, Va., six ea., spectrograph analyzers, Melpar Model SA-1, (PR C-002109 and MIPR R-60-7207-LYN), $87,000.

J. A. Maurer, Inc., Long Island City, N. Y., 28 ea., camera body assemblies, type P-220, related item and maintenance data, end use: B-66 aircraft, (PR MO-9-6720-1110 and MIPR R59-6-SC-USAEPG-PO and amendment No. 1), $91,003.

General Precision Laboratory, Inc., Pleasantville, N. Y., engineering services to assist with installation and testing of AN/APN/81, 36/APN/89 and AN/APN/102 doppler navigation systems, end use: KC-135 and B-52 aircraft, (PR's EC-O-S-6120 and EC-O-6121), $58,359.

Sperry Gyroscope Co. Division, Sperry-Rand Corp., Great Neck, L. I., N. Y., product improvement of power supply PP-1073/APN-59 and indicator IP-268/APN-59 (components of AN/APN-59 radar set used in C-133A and KC-135A aircraft), (PR EC-9-16K1-4573), $343,072.

The Sheffield Corp., Dayton, Ohio, imposed high frequency vibration system, (PR BM-9-MMP-9134), $158,000.

O. W. Liebiger Research Laboratories, Inc., Hoosick Falls, N. Y., translation services, (PR C092073), $90,000.

Beech Aircraft Corp., Wichita, Kan., service test of generator sets, gasoline engine EMU-6/E, 60KW, (PR EM-9-ST-6422), $236,875.

Apparatus Division, Texas Instruments, Inc., Dallas, Texas, 18 ea., airborne moving target indicators and modification of AN/APQ-86(XH-1) radar sets, spare parts and data, end use: L-23 aircraft, (MIPR RO2-99098-SC-01-23 and amendment No. 2), $216,658.

Transport Division, Boeing Airplane Co., Seattle, Wash., fatigue testing of five each wing panels and one each outboard wing, (PR SJ-9-1510-7213), $264,279.

Kollsman Instrument Corp., Elmhurst, N. Y., product improvement program for MD-1 automatic astro compass (applicable to B-52 aircraft), (PR EG-9-05A-4784), $162,800.

Graflex, Inc., Rochester, N. Y., 29 ea., cameras, still picture, identification type CI-1, FSN-EH-6720-244-6821-J360; 55 ea., cameras, still picture, type KE-7, 35mm, with accessories, FSN-EH-6720-577-4105-J360; 26 ea., cameras, still picture, view 4x5 inches, FSN-EH-6720-597-2590-J360, (used as ground support equipment), (MIPR's R59-733/383NSF, R59-638/383NSF and R59-717/383NSF and amendments No. 1 and 2), $30,805.

The Goodyear Tire & Rubber Co., Akron, Ohio, 32 ea., wheel assemblies (for 20.00-20 wheel, main), type III, Aerno 41-1181 and data (use installation and initial spares for C-130B aircraft), (MIPR R59-2220-157-NOas), $29,074.

Andrea Radio Corp., Long Island City, N. Y., 2,000 ea., control intercommunication set, C-824A/AIC-10, end use unknown, (PR MDO-5831-16108), $180,000.

Lear, Inc., Grand Rapids, Mich., components of MC-1 and MM-4 automatic flight control system, (PR's MA-9-05F-779 and amendment No. 1, MA-9-05F-914, MA-9-05F-1271 and EG-9-05F-4778, $463,-437.

Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, N. J., R3350-32W engines (for Navy aircraft), (MIPR R-59-1985-135 NOas and amendment No. 1), $3,101,762.

Chicago Telephone Supply Co., Elkhart, Ind., cermet element resistor refinement program, (PR BM-9-MMP-9135), $225,000.

Mitchell Camera Corp., Glendale, Calif., 12 ea., camera sets, CMY-5, motion picture, 16 mm., high speed, FSN-EH6710-229-0059-J360, used as ground support equipment, (MIPR R59/688/383NSF), $82,566.

Boeing Airplane Co., Wichita, Kan., engineering and procurement of long lead time items of instrumentation and equipment for B-52 systems compatibility program, (PR SE-O-1510-3031), $7 million.

Beech Aircraft Corp., Wichita, Kan., RL-23D aircraft, spare parts and ground support equipment, (MIPR R60-18-TCSMC-A), $400,000.

Crosley Division, Avco Manufacturing Corp., Cincinnati, Ohio, 22 ea., control panels, GE P/N 533E241G2, applicable to MD1 and MD1A fire control system (used on B-66 aircraft), (PR WR-9-1270-1017), $26,087.

Boeing Airplane Co., Seattle, Wash., type KC-135A airplanes, spare parts, ground support equipment, data and mobile training unit, (PR SJ-O-1510-3003 and amendment No. 1), $30,271,000.

Oshkosh Motor Truck, Inc., Oshkosh, Wis., 60 ea., type AF/S32U-10 snowplows, truck mounted, 4 x 4, 54,000 lbs. gross vehicle weight for removal of snow from aircraft runways, (PR EM-9-3825-6357), $1,270,000.

Van Zelm Associates, Inc., Baltimore, Md., metal bender energy absorber, (PR EM-9-RD-6325), $126,733.

General Electric Co., Waynesboro, Va., 13 ea., panels, a.c., control, contractor's P/N 3S2781F123A-1, Aerno 42, 6103; 13 ea., regulators, a.c., contractor's P/N 3S2795H111A-1, Aerno 42-6102, and spare parts (spares for F-106A and B aircraft), (PR's EA-9-03C-4862 and EA-9-6115-5012), $38,853.

Atlas Film Corp., Oak Park, Ill., one ea., production of a 35mm. Eastman color negative motion picture entitled, "Oxygen Nitrogen Generating Plant Distillation Column Control," P19291, (PR EM-O-MP-6327), $36,996.

AiResearch Manufacturing Co. of Arizona Division, The Garrett Corp., Phoenix, Ariz., modification and overhaul of, 31 ea., power units, AiResearch model GTU85-2, gas turbine engine, Aerno 42-2353, spare parts and data for C-133 aircraft, (PR's EA-9-O2B-4809 and WR-9-835-5967), $104,-539.

Continental Motors Corp., Muskegon, Mich., 30 ea., O-205-1(C90-8F) aircraft engines for the L-18C aircraft, (MIPR R60-5001-TCSMS-E), $28,825.

C. P. Goerz American Optical Co., Inwood, L. I., N. U., one ea., shutter, (Kilfit), I. D. No. 792018, vibration free, 3½", high speed in accordance with work statement dated Mar. 5, 1959, handbooks and drawings for service test, (PR EC-9-10-4919), amount not given.

Admiral Corp., Chicago, Ill., 386 ea., controls, radio set, C-1904/ARC-27, S/N 5821-5797 in accordance with MIL-C-25872 (USAF) dated June 16, 1958, use: supply installation and spares, (PR's SB-9-16A-5040 and MD-9-5821-36050), $90,324.

System Development Corp., Santa Monica, Calif., additional facilities for the SAGE programming and training program, (PR BI-O-F-9023), $200,000.

Documat, Inc., Belmont, Mass., modification of 35 ea., viewers, still picture, microfilm, type AR-10 and ground support equipment, (PR MO-9-6730-1614), $50,873.

Navy Contracts

Washington—Following is a list of unclassified contracts for $25,000 and over as released by Department of the Navy, Bureau of Aeronautics:

Continental Aviation and Engineering Corp., Toledo, Ohio, conduct an engineering program on the model R975-46A Engine, NOas 60-0159-c (PP-23-209-9), $62,825.

Webcor, Inc., Chicago, Ill., 368 ea., magnetic tape recorders, less control and indicator in accordance with Specification MIL-R-19533(Aer) with exceptions, NOas 60-0204-a(IFB 600-2402-59-A), $240,098.

Bell Aircraft Corp., Buffalo, N. Y., 150 KY-55/ARW audio decoders and 150 MT-950/ARW mounts in accordance with Specification MIL-R-7924A(Aer), NOas 60-8014-a (PD-32-3638-0), $52,050.

National Research Corp., Cambridge, Mass., establish procedure for the production of metals of high melting point, NOas 60-6003-c(AE-41-4769-9), $73,343.

Lockheed Aircraft Corp., Marietta, Ga., 10 ea., model GV-1 airplanes, in accordance with detail specification SD-537-1-2-(S), NOas 60-0151-r(PD-22-3219-0), $19,222,583.

Royal Industries, Inc., Alhambra, Calif., laboratory qualification tests on ATP-N1, ATP-N2 and ATP-N3 tanks and associated containers in accordance with Specification MIL-T-18847(Aer), NOas 60-0177-c(AE-62-2288-0), $146,560.

Douglas Aircraft Co., Inc., El Segundo, Calif., 180 airplanes, model A4D-2N, in accordance with detail specification SD-495-2N-2, NOas 50-0128-1, (MA-53-3213-0), $58,816,010.

Bell Aircraft Corp., Buffalo, N. Y., ARR-26 radio receivers and components in accordance with specification MIL-R-5062A (Aer), NOas 60-0227-a(PD-32-3623-0), inventory No. IFB 600-213-60, $156,204.

Del Mar Engineering Laboratories., Inc., Los Angeles, Calif., 10 tow target reel assemblies, Model DX-4A, NOas 60-4091-f (MA-45-237-0), $118,750.

McDonnell Aircraft Corp., St. Louis, Mo., materials and services to modernize the existing fire alarm system at Naval Industrial Reserve Aircraft Plant, NOas 59-0048-C-(PP-31-4451-9), $48,672.

Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill., conduct an investigation and develop new techniques for the production of prealloyed molybdenum alloy sponge for the direct extrusion of molybdenum powder, or prealloyed sponge to billets suitable for rolling into sheet, NOas 60-6019-c(AE-41-4785-9), $122,000.

Singer Manufacturing Co., Bridgeport, Conn., 600 AN/ASR detecting equipments and related items in accordance with specification MIL-D-19318A(Aer), NOas 60-0714-f(PD-32-3618-0), $906,650.

Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y., services and materials for 18 UF-1G aircraft for conversion to UF-2G and seven SA-16A aircraft for conversion and rehabilitation to UF-2G aircraft, NOas 60-8004-r(PD-22-3247-0), $3,655,556.

New York University, New York, conduct an investigation to develop improved titanium organic compounds, NOas 60-6011-c-(AE-42-2276-0), $41,854.

The Martin Co., Baltimore, Md., services and materials necessary for modernization of 57 model P5M-2 aircraft, NOas 60-0219-(MA-33-Aer-126-60), $30,600,000.

Janitrol Aircraft Division, Surface Combustion Corp., Columbus, Ohio, one preproduction sample and four evaluation units, preheated, portable, gasoline driven, model NPH-2 in accordance with specification YMA-118, NOas 60-6023-c(MA-55-492-9), $129,768.

Chemical and Metallurgical Division, Sylvania Electrical Products, Inc., Towanda, Pa., materials, services and personnel to investigate and develop processes for producing improved quality molybdenum alloy sheets, NOas 60-6018-c(AE-41-4760-59), $356,004.

Division of Sponsored Research, Massachusetts Institute of Technology, Cambridge, Mass., conduct an investigation of chromium-base alloys for use at elevated temperatures, NOas 60-6022-c(AE-41-2295-0), $43,000.

Chance Vought Aircraft, Inc., Dallas, Texas, furnish engineering services and materials necessary to conduct the Regulus I weapon system support program, NOas 60-0187-c(GM-20-1818-0), $95,000.

Southern Research Institute, Birmingham, Ala., investigative program to assess the significance for design purposes of experimental techniques for evaluating the resistance of high strength structural alloys to catastrophic failure by brittle fracture, NOas 60-6040-c(AE-41-2311-0), $30,820.

All American Engineering Co., Wilmington, Del., services and materials to operate government-owned test equipment, arresting equipment and instrumentation in performance of BuAer authorized test program, NOas 60-6008-c(SI-23-5765-0), $241,-500.

Electronics Division, National Cash Register Co., Hawthorne, Calif., 12 months of trained technical non-personal services to provide preventative and emergency maintenance of computing system, NOas 60-4081-f(CM-2-4820-0), $57,744.

Daystrom Instrument Division, Daystrom, Inc., Archbald, Pa., 227 AQA-1 azimuth range indicators and components in accordance with specification MIL-I-19443A(Aer), with exceptions, NOas 60-0190-f(PD-32-3620-0), $821,735.

Marine Laboratory, University of Miami, Miami, Fla., conduct research studies in the field of weather radar and further develop a specialized weather radar receiving system, NOas 60-6026-c(AY2-1420-0), $64,-840.

The Martin Co., Baltimore, Md., removal and/or modification and preparation for shipment of government-owned property in aircraft, NOas 60-0216-c(PD-22-3275-0), $500,000.

Owens-Corning Fiberglas Corp., Toledo, Ohio, investigation and development of a wire-insulation combining the properties of extruded insulation material and woven glass braid, NOas 60-6017-c(AE-82-2273-0), $55,254.

College of Engineering, New York University, New York, conduct an investigation and perform tests to develop high temperature resistant resins bases on complex information with organotitanates, NOas 60-6006-c(AE-42-2291-0), $28,500.

Westinghouse Electric Corp., Washington, D. C., services and materials to conduct a product improvement program on the model J34 turbojet engine, NCas 59-0287-c(PP-21-166-59), $4,800,000.

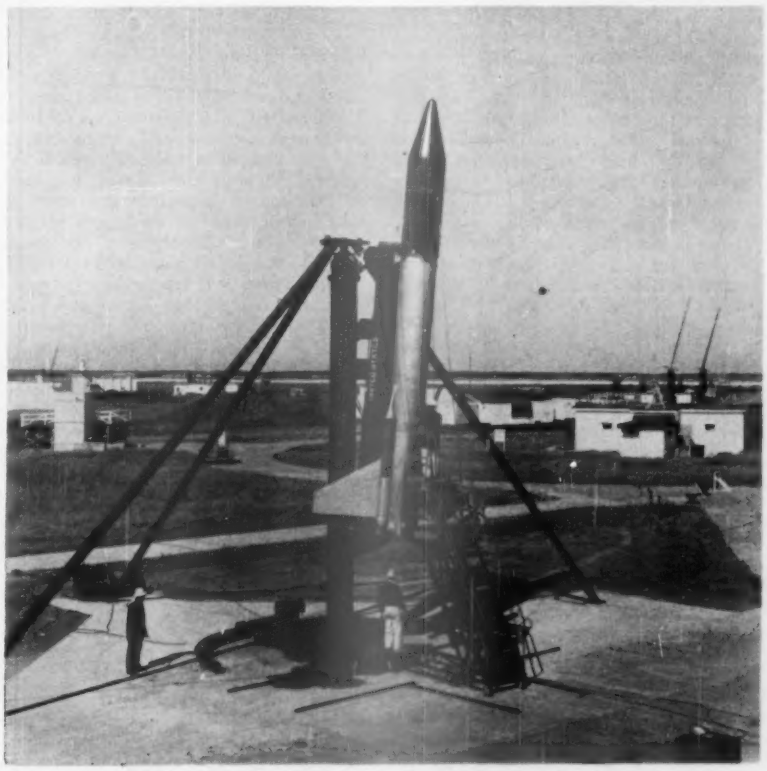
Crucible Steel Co. of America, Midland, Pa., materials and services for investigation of hot salt corrosion of titanium alloys at elevated temperatures, NOas 60-6004-C-(AE-41-4783-9), $77,900.

John B. Hollingsworth Co., Phoenixville, Pa., design, develop and furnish five mobile diesel engines driven 5 kw. generator sets, model NC-9, NOas 60-6013-c(MA-56-513-9), $26,405.

Onsrud Machine Works, Inc., Niles, Ill., furnish materials and services necessary to rebuild, restore and prepare for shipping one government-owned Onsrud A-80-A contour milling machine, NCas 60-0814-c(IP-31-4452-9), $35,925.

Hamilton Standard Division, United Aircraft Corp., Windsor Locks, Conn., propeller equipment in accordance with applicable portions of specification MIL-P-5447A-(ASG) with deviations, NOas 60-0713-f (PD-41-1997-9), $446,477.

Bell Aircraft Corp., Buffalo, N. Y., 150 R-425B/ARW-59 radio receivers and 150 MT-950/ARW mounts in accordance with specification MIL-R-7924A(Aer), NOas 60-8024-a (PD-32-3639-0), invitation number IFB 600-218-60-A, $98,400.

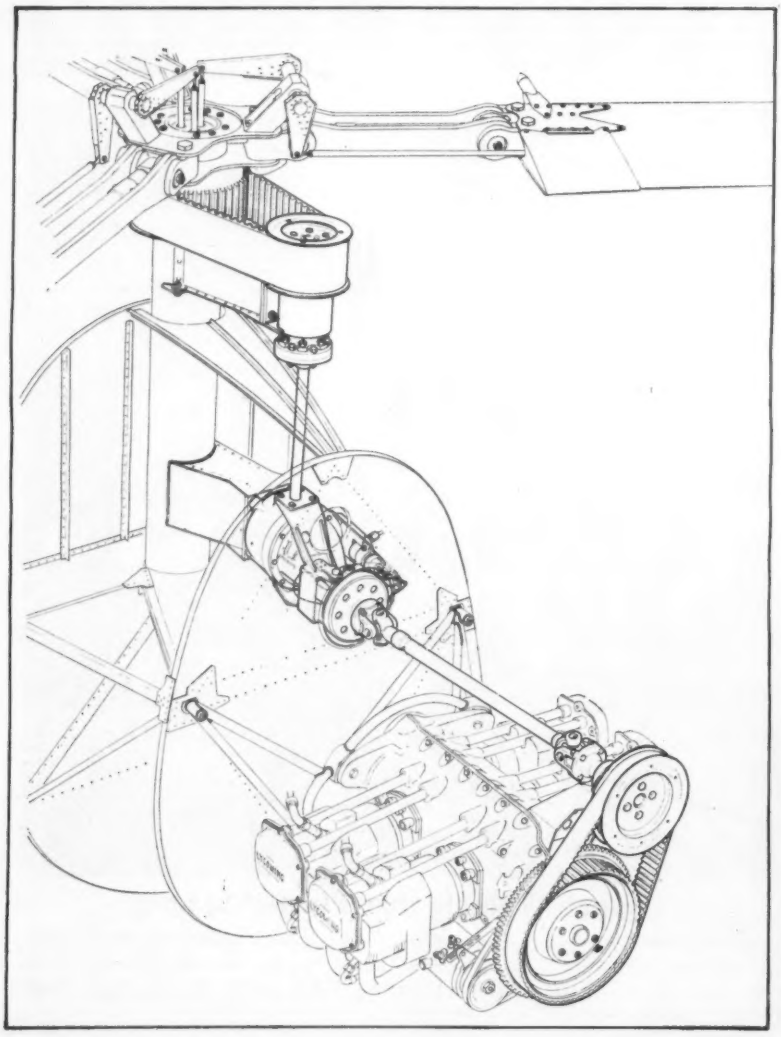


Launch Vehicle for Plastic Sphere

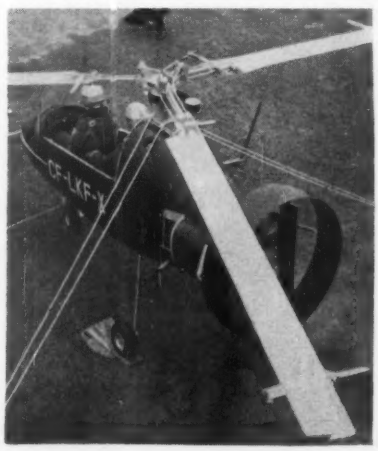
Launching vehicle which carried an inflated 100-ft. diameter aluminized plastic sphere 250 mi. high (AW Nov. 2, p. 37) has a Thiokol Sergeant and two Recruits for its first stage, and an Allegany Ballistic Laboratory X-248 rocket for the second stage. Payload is folded in a 26½ in. round container.

Avian 2/180 Gyroplane starts ground test at Waterloo-Wellington Airport, Kitchener, Ontario, Can. High-speed taxi runs were completed during the second day of test program. Ron Peterson is Avian pilot; Peter R. Payne, company president, is in aft seat.

Avian 2/180 Gyroplane Readied for Initial Flight



Avian 2/180 Gyroplane is undergoing ground trials in Ontario, Canada, prior to making its first flight. Original flight date was Sept. 30; postponement is attributed to company moving most of its operations to a new plant, to a second prototype being built for the certification program (AW Nov. 16, p. 99), to the company deciding to fabricate components instead of subcontracting, and to negotiations with and reports for government agencies which have consumed more time and money than was foreseen. Drawing at left shows layout of mechanical drive system for the second prototype, 2/180B. First prototype is shown below during initial checkout of the rotor system at the Avian plant in Georgetown, Ont. Aircraft is tied down and chocked. During initial trials the Gyroplane is being operated without its canopy; a side panel and lead-ins to the engine air intakes also are removed. Gyroplane is designed to cruise at 150 mph. at 75% power. Normal approach speed for a dead stick landing is 20-25 mph.; touchdown speed is 15 mph.



CAB Accident Investigation Report:

Breather Discharge Caused Nacelle Fire

About 1623, Jan. 17, 1959, Eastern Air Lines Flight 704 made an emergency landing on runway 9R of the Miami International Airport. The landing was made because of an engine failure and uncontrollable fire immediately after takeoff. Of the five crew members and 12 passengers, one passenger received minor injuries. The aircraft, a Lockheed 1049G, N 6240G, was badly damaged by in-flight and ground fire, and by impact when the right main gear collapsed.

It is the Board's analysis of this accident that the No. 3 engine failure resulted from an initial failure of a connecting rod, probably No. 10. It is believed that during the engine failure progression an abnormal exhaust flame occurred which ignited a flammable discharge from the outboard breather exit of the engine. The resulting flame then penetrated the aluminum wheel well doors igniting a fire in zone 3-A of the nacelle, an area not presently serviced with fire extinguishing agents or fire detection.

As corrective measures the Board has recommended to the Federal Aviation Agency that consideration be given to a requirement that zone 3-A be serviced with fire detection and extinguishing equipment; also, that action be taken to ensure that an abnormal exhaust flame cannot ignite an unusual breather discharge. The Board further recommended that the wheel well doors be replaced with those made of fireproof materials.

In connection with the accident, the Board investigated and found the Dade County Port Authority Airport rescue and fire-fighting department deficient because of a lack of equipment capability. The Board was informed that this deficiency will soon be corrected by additions to the equipment.

INVESTIGATION

Eastern Air Lines Flight 704 is a daily nonstop flight from Miami, Fla., to Detroit, Mich., scheduled to originate at 1555[1] and terminate at 1948. On Jan. 17, 1959, the assigned flight crew consisted of Capt. James W. Rush, Pilot Robert P. Harkless, Flight Engineer Russel E. Eshbach, and Flight Attendants Esther M. Tharpe and Wanda Carr.

The necessary documents preparatory to the trip were completed in a routine manner and well in advance of flight time. A review of these papers showed they were complete and properly executed. The flight plan showed the flight was planned in accordance with instrument flight rules, although weather conditions at Miami were clear except for a few distant cumulus clouds and the visibility was 12 mi. The load manifest showed the gross takeoff weight of the aircraft was 107,776 lb.; the maximum allowable weight for takeoff for the proposed operation was 124,310 lb., and the maximum weight for landing was 124,310 lb. The load was properly distributed.

Flight Engineer Eshbach performed a preflight inspection of N 6240G. He stated that while inspecting the right main landing gear wheel well and No. 3 nacelle area he found a considerable amount of oil accumulation in the wheel well and streaking the sides of the nacelle and wheel well doors. The engineer said the oil accumulation and streaking was quite normal and in characteristic patterns from the No. 3 engine and engine breather exits. He said the same conditions existed in and around the left wheel well and were normally existent on all aircraft of this model and make. The flight engineer added that he found some hydraulic fluid on the right main gear strut. This was not unusual because the right strut was repacked during an 18-hr. layover period for the aircraft before Flight 704. He stated that his preflight was complete and he was satisfied there were no leaks.

At 1559 Flight 704 received taxi clearance to runway 27R for takeoff. The distance involved was short; however, because of heavy traffic, both ground and air, it was about 20 min. before Flight 704 was No. 1 for departure. The crew members stated that during this time, while in runup position, a thorough and satisfactory pretakeoff check was made and, because of the delay, a plug defouling and burnout procedure was accomplished.

Pilot Harkless made the takeoff at 1621. All crew members said that powerplant response was normal and the aircraft accelerated properly. They stated that the throttles were closely aligned at takeoff power and power and pressure indications were equal and stable. The engineer found the engine temperature indications within the normal range. When the aircraft was airborne the landing gear control was positioned to "gear up," and while the gear was in transit maximum continuous power was established. Again the crew found the power indications equal and stable from all powerplants.

Capt. Rush stated that about 150 ft. above the runway and about the time the gear was retracted he saw a fluctuation of the No. 3 engine tachometer. The rpm. dropped from 2,600 to 2,300 and returned. Simultaneously he noted a power decay for the engine. The flight engineer saw these conditions and noted that the engine ignition analyzer, then set to the No. 3, showed two secondary shorts in the No. 12 cylinder. Capt. Rush ordered the engine shut down. The engineer stated that he closed the throttle, cut the mixture, and depressed the No. 3 feathering button, holding it until he saw the propeller stop. He then turned off the No. 3 fuel boost pump, the generator, and the No. 3 fuel tank selector valve and closed the engine cowl flaps. According to the Eastern Air Lines emergency procedure, unless a fire is known to exist the emergency firewall shutoff valve is not to be actuated; therefore, because no fire was indicated at this time, this was not done.

As near as can be determined, about the time the engine failure procedure was in progress Miami tower personnel saw smoke, then flames, trailing the aircraft from the No. 3 engine nacelle area. The local controller informed the flight and cleared it to land using any runway. The airport emergency equipment was alerted at the same time.

Bell Sounded

The crew stated that before the aircraft was over the west end of the runway and when the last steps in the engine-out procedure were taken, the master fire-warning bell sounded and the No. 3 engine zone 1 fire-warning light came on. The zones 2 and 3 lights quickly followed, at which time Capt. Rush took control of the aircraft. The flight engineer positioned the fire extinguisher selector to the No. 3 engine and when Capt. Rush ordered him to "fight the fire" the first of two Freon bottles was discharged. Capt. Rush estimated the aircraft was then just past the west end of the runway. The warnings continued and the second bottle was discharged. The action was ineffective although, sometime in this sequence, the zone 1 warning light went out. Pilot Harkless saw fire from the No. 3 engine nacelle area reflected on the inboard side of the No. 4 nacelle. Also, about this time the odor of smoke permeated the cockpit.

At this time fire was known to exist and extinguishing action had been taken. Therefore, the company's emergency procedure required that the emergency firewall shutoff valve be pulled and the cowl flaps be opened. This was not done. The flight engineer stated he recognized the requirement and omission. In essence, he credited the rapidly occurring events and the compounded emergency as part of the reason for the omission. He also said the emergency steps taken were not checked against the cockpit checklist as there was little opportunity for such action in the short time available.

Numerous aeronautically qualified witnesses saw the aircraft during the phase of flight just described. Many furnished statements and several testified as to their observations before the Board in public hearing. From this source it was learned that an abnormal dense gray-white smoke was seen emanating from the No. 3 nacelle during the last part of the takeoff roll just before the aircraft became airborne. One witness who saw this smoke stated he saw flames on the right side of the nacelle just

[1]All times herein are Eastern Standard based on the 24-hr. clock.

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RESUME FROM ROHR

TO PROFESSIONAL AND ADMINISTRATIVE PERSONNEL

Name	Rohr Aircraft Corporation
Address	Main Plant and Headquarters: Chula Vista, California (near San Diego) Manufacturing Plant: Riverside, California Assembly Plants: Auburn, Washington; Winder, Georgia
Age	Established 20 years
Health	Financial health excellent - Sales this year, $184,000,000 Backlog approaching a quarter-billion; 68% commercial
Present Position	World's largest producer of components for flight
Experience	After years of experience in the engineering and manufacture of ready-to-install power packages, Rohr today is widely diversified in many fields of structural flight components. For instance, the design and production of such major components as fuselage sections, jet pods and struts, empennage assemblies, flap tracks, missile racks, wing leading edges, etc. Perhaps even more important is Rohr's leadership in the development and manufacture of stainless steel honeycomb sandwich panels, and advanced research in the field of practical usage of exotic metals.
Reason for these openings	Rohr is selecting successful professional and administrative personnel to join its highly-regarded team.
Business References	America's major aircraft companies
Availability	We are available for interviews whenever it is mutually convenient. Please forward details of your education and experience to Mr. J. L. Hobel, Industrial Relations Manager, Rohr Aircraft Corporation, AW-8 Chula Vista, California

ROHR
AIRCRAFT CORPORATION

after the aircraft became airborne. Another witness saw the flames immediately thereafter and stated that as the aircraft passed his position, affording a side view of the outboard side of the nacelle, it was his impression the flames were coming from the right (No. 1) PRT (power recovery turbine) exhaust outlet. Both of these witnesses were qualified mechanics and stated the flames were abnormal. They described them as intermittent and a dirty orange-red color trailing rearward along the nacelle area and visible even when viewed into the sun.

A few seconds later, when the aircraft was near the west end of the runway and about 250 ft. above the ground, flames burst out of the nacelle area and, viewed from the rear, seemed to come from and surround the aft nacelle area. Tower personnel, located on the opposite side of the nacelle, first saw gray-white smoke and then flames shortly after the aircraft became airborne. One stated that when viewed from a quartering rear position the flames extended below and to the rear of the nacelle. Many other witnesses saw the smoke and flames about this time. Most agreed the gray-white smoke was observed first and became heavier as the aircraft continued; also, when the flames appeared they were intermittently visible in the smoke. Of all these witnesses, none could recall the landing gear position or whether or not the No. 3 propeller was stopped. Several explained this was because their observations were almost hypnotically fixed to the smoke and fire.

In the Constellation, Capt. Rush turned left as soon as possible to establish a base leg for landing on runway 9R, the parallel runway to 27R in the opposite direction of takeoff. He stated that the pattern speed did not exceed 140 kt., the altitude did not exceed 400 ft., and the pattern was as close as possible. He also estimated the first Freon discharge was before the first left turn and the second was shortly after this turn. The landing gear was extended during the left turn to final approach and landing flaps were extended shortly thereafter. Both operations were accomplished normally. The captain said the touchdown was smooth and very close to the approach end of the runway. He said that during the rollout normal system braking rapidly "faded out" and became ineffective. All four throttles were pulled into reverse range, at which time the aircraft yawed to the left. About this time it was learned the No. 4 engine had stopped and nose wheel steering was inoperative. Secondary braking was initiated but also quickly faded out although the auxiliary hydraulic pump and manual pump were operated. It was also noted the primary and secondary hydraulic quantity indications were zero.

With the partial braking available, some reverse thrust and normal rolling deceleration, the aircraft slowed appreciably but did not stop until it overran the east end of the runway about 75 ft. Then the right main landing gear collapsed.

From variously positioned ground witnesses, who saw the flight from the first left turn to landing, it was established that flames were visible most of the time as the aircraft progressed through the pattern. None saw any parts fall from the aircraft in flight. The fire became much worse on the final approach and during the landing roll flaming metal fell from the aircraft and flaming fluid poured down the main gear onto the runway leaving a path of fire. One witness said that on final approach the No. 3 propeller was turning slowly; another said it was stopped. A photograph taken during the ground roll showed heavy flame pouring out of the aft nacelle area behind the extended main gear strut and passing the trailing edge of the wing above and below the flaps.

The stewardesses prepared for cabin evacuation before the aircraft stopped, cautioning passengers to use the left side and to remove their shoes and glasses before using the emergency slide chute. The main cabin door was opened and the chute hooked up while two male passengers left the cabin through window exit 17-A. At a request from Stewardess Tharpe they came to the cabin door, and held the bottom of the emergency slide chute for the others to slide down. The crew also used the chute, with Capt. Rush last after a final check of the cabin. One elderly and partially disabled passenger received aggravation to his existing condition during the evacuation. Though none of the crew could estimate the evacuation time the rapidity and efficiency described by passengers and witnesses indicated it could not have taken much more than a minute.

The Dade County Port Authority airport emergency rescue and firefighting equipment intercepted the aircraft from a crossing runway (17-35) before it stopped. After learning that all occupants were safely out of the aircraft the emergency personnel began to fight the fire, which was not extinguished for approximately 30 min. and not until assistance was received from off-airport fire departments from Miami, Miami Springs, Hialeah, and Dade County. As a result, a part of the accident investigation and public hearing was devoted to determining what equipment was available to the rescue and firefighting department, the capabilities of this equipment, and the tactical manner in which it was used to fight the fire in this accident.

From competent witnesses of the Airport Fire Department it was learned that foam was used as the principal extinguishing

Mi-1 Helicopter Competes in Show

Soviet pilot A. D. Itzkov makes an "obstacle" takeoff and landing in an Mi-1 helicopter during the second annual All-Union Helicopter Sport Competition at Tushino. Container on left side, aft of cockpit, is an auxiliary fuel tank.

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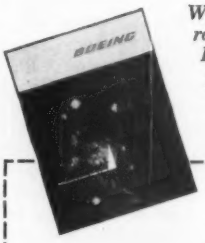

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agent and the total capacity of the four pieces of equipment manned at the accident was about 2,150 gal. of water-foam mixed in a 10 to 1 ratio. This total capacity could be discharged in about five minutes. Additional foam concentrate was not carried to the accident scene and other than hand extinguishers the department had no extinguishing agent to supplement the foam. Water, however, was available to any part of the airport through a system of wells and hydrants.

Compared with NFPA (National Fire Protection Assn.) suggestions, which, in this field, are widely accepted in the absence of any regulatory matter, the amount of foam available at the scene was well below the amount suggested. As indicated, the suggested amount of supplementary extinguishing agent, such as dry chemical or carbon dioxide, was not possessed. The discharge rate capacity of the equipment was about one-half that of the NFPA suggested rate. In addition, the Port Authority lacked such important rescue equipment as power saws and escape stairs.

During the investigation comparisons were also made between the Miami International Airport rescue and firefighting equipment and equipment capabilities and those of other airports of similar size and generating comparable traffic factors. The comparison showed Miami was far below New York, Los Angeles, San Francisco, and Chicago.

The equipment reached the aircraft before it stopped and the prime piece of equipment was positioned at the cabin door to carry out the first and all-important mission of protecting and assisting the evacuating occupants. When this was assured, this equipment was moved in front of the burning wing, close to the fuselage. Another foam truck was positioned behind the wing and at the same time hose lines were laid to water sources. Both foam trucks laid foam on the fire according to accepted techniques. According to nearly all observers, in a few minutes the fire, then being fed by about 1,700 gal. of fuel from the right wing fuel cells, was under control and nearly out. At this time the foam supply at the scene was exhausted. Two flashbacks of the fire then occurred and it rekindled to its original intensity. The lieutenant in charge of the airport equipment at the scene stated, in essence, that when the fire was nearly out and despite the flashbacks only a small amount of additional foam would have enabled his personnel to have put out the fire. Without it, extinguishment took the combined efforts of his equipment and the off-airport equipment that reached the scene about the time the fire rekindled. The fire was finally extinguished by using several thousand gallons of water. The evidence indicates that the difficulty encountered in extinguishing the fire was caused by the lack of equipment rather than improper firefighting techniques and tactics.

Concerning future plans, the airport superintendent of maintenance and fire protection stated at the public hearing that bids would soon be advertised for the purchase of a new firefighter and a chemical truck. He said that specifications for the firefighter included a foam concentrate capacity of 250 gal., a water capacity of at least 1,000 gal. and a discharge rate of 1,000 gpm. A specification for the chemical unit was 500 lb. of dry chemical, which is considered equivalent to 1,500 gal. of foam.

At the accident scene N 6240G stopped on a heading of 110 deg. resting on the left main gear, nose gear, the outboard portion of the right wing and engine nacelles, and the right vertical fin. In-flight and ground fire severely damaged the right wing and powerplants and heat rippled the fuselage skin on the right side of the aircraft from the rear pressure bulkhead to the crew entrance door. Fire trailing rearward during the approach and ground roll burned the right side of the empennage. When the gear collapsed impact forces buckled the right wing and right horizontal stabilizer upward and crushed the lower part of the right vertical fin.

Examination of the aircraft and the crew statements established that the in-flight fire was confined to the No. 3 nacelle and adjacent areas aft of the nacelle. The other powerplants and structure did not cause or contribute to cause of the accident. Despite this advantage the severity of the fire in the areas most important to the investigation destroyed much valuable evidence and the ground fire damage made it most difficult to ascertain and trace the in-flight fire patterns with certainty.

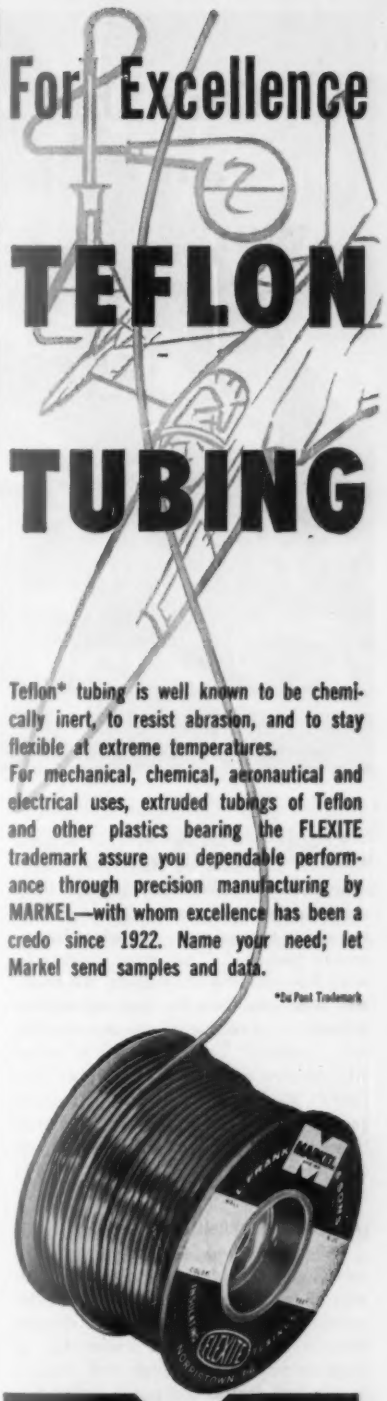
Nacelle Zones

On the L-1049-series aircraft the No. 3 engine nacelle installation is divided into four zones. Briefly, zone 1 is the engine power section which is located forward of the engine fire seal; zone 2 is the engine accessory section located between the fire seal and the stainless steel firewall; zone 3 is the area from the firewall rearward to the auxiliary fire shield (some fluid-carrying lines are routed through this zone and it houses the right main gear wheels and the lower portion of the gear strut when the gear is retracted); zone 3-A is the area aft of the auxiliary fire shield, located just in front of the front wing spar, rearward to the rear wing spar. The right main landing gear strut is hinged to the rear spar.

Testimony of a Lockheed representative at the public hearing was that the auxiliary fire shield which divides zone 3 and 3-A in the No. 3 nacelle of the L-1049 was for the purpose of additional safety beyond regulatory requirements. The installation, he said, was not dictated by any adverse operational experience. He stated that with the landing gear up and wheel well doors closed a fire seal was formed between the two zones; however, with the landing gear down both zones were open to the atmosphere and to each other.

The fire detector system used in the aircraft engine nacelle is a double loop detector system routed through zones 1, 2, and 3. Zone 3-A is not served by the detector circuit. Following the accident, examination revealed the system even though badly burned was capable of functioning satisfactorily.

The aircraft's fire extinguishing system is a dibromodifluoromethane (commonly referred to as Freon) type, which, as it pertains to the No. 3 nacelle, consisted of two Freon bottles located in the upper section of zone 3-A from which the extinguishant is routed to zones 1, 2, and 3. The system



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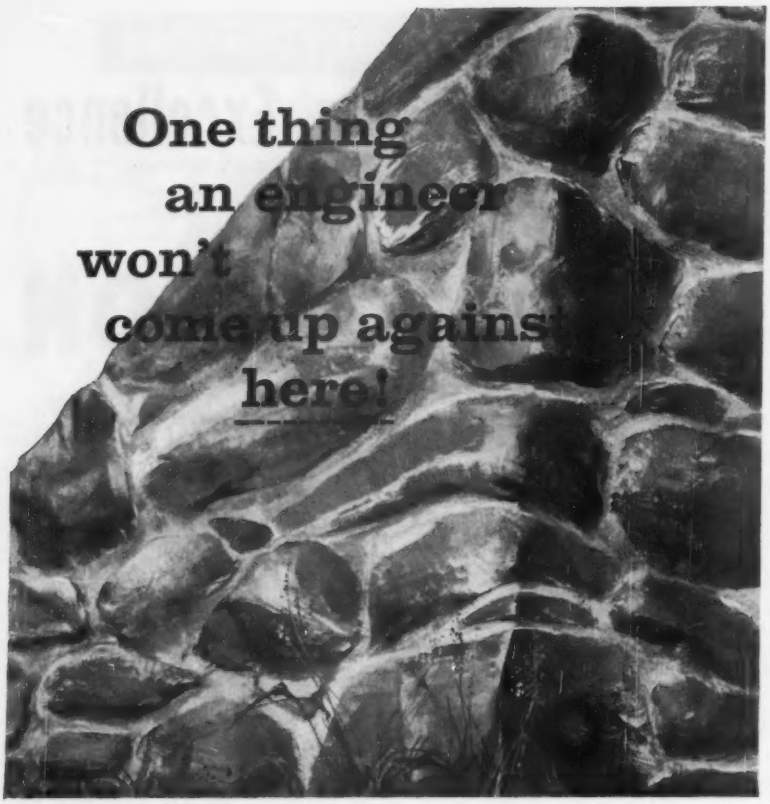

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does not route the extinguishant to zone 3-A, and thus would not be available to this area with the landing gear up and the wheel well doors closed. From the evidence available and from the tests performed following the accident it was determined that the system operated normally when actuated by the flight engineer although, obviously, the fire which existed at that time was not extinguished.

Examination of the No. 3 engine controls revealed the throttle was about one-half open and the mixture control for this engine was in the fifth notch from cutoff.

External examination of the No. 3 engine showed it was completely intact and remained securely mounted in the nacelle. The cowling was extensively damaged by fire and the nearly downward flow of molten metal clearly distinguished the damage as that from ground fire. The No. 3 power case sections were intact and all cylinders remained securely mounted on the power-cases. Both the induction and exhaust manifolds were intact and showed no evidence of leakage.

From outward appearance it was impossible to determine that this engine had failed internally.

The front and rear sumps, however, contained large amounts of ferrous and non-ferrous metals later identified as pieces from the front row master rod, connecting rods, pistons, and piston rings, and from the front main bearing. The Nos. 1 and 2 PRT turbine wheels were nicked by metal which passed through these assemblies. The No. 2 wheel was oil soaked; the No. 3 was undamaged. All PRT flight hoods were undamaged, properly aligned, and securely mounted.

Internal examination of the engine showed a flange failure of the inner race of the front main bearing. The rear flange of the outer race was broken away in several areas. Metal pieces were also located in the main bearing raceway and there was indication the pieces created binding causing the outer race of the bearing assembly to spin in its retainer. Laboratory examination of these parts indicated the failures resulted from overload conditions rather than a fatigue or faulty condition of the parts.

Examination of the front row power section disclosed that all connecting rods and the master rod were broken off. All of the front row pistons, excepting Nos. 6 and 12, were lodged in their respective cylinders. Nos. 6 and 12, which were badly deformed and crushed into balls, were found in the front case section. Nearly all pistons showed a damage pattern in the form of polishing on the rear side of the top ring lands and breaking of nearly all piston skirts on the front side. This damage pattern showed that the pistons were cocked in the cylinders while the failure of the engine was in progress. The broken master rod was flared as a result of unbalanced operating loads. The stub end of the master rod was wedged against the crankshaft counterweight so that the crankshaft could not be rotated. Relatively, the assemblies and components of the rear row of the engine were in good condition.

Examination of the failed connecting rods showed all except No. 10 were broken off cleanly about six inches from the piston pin. The No. 10 rod indicated a splitting

type failure in the blade section about five inches from the piston.

Except for ground fire damage and a rearward bend in the No. 1 blade, the No. 3 propeller and related mechanisms were in good condition. The stop rings were properly set at 81 deg., full feathering and minus 21½ deg., full reverse. Impact markings on the shim plates showed that when the right gear collapsed the blade position was 67 deg., or 14 deg. less than full feathering. Some molten metal particles were found on the governor side of the No. 3 governor screen and in the auxiliary check valve.

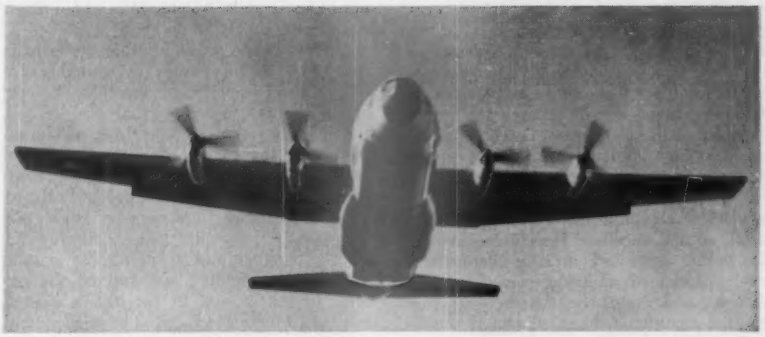
In zone 1, between the Nos. 2 and 3 PRTs, the HRD (high rate discharge) line of the Freon extinguisher system was torn apart by an explosive-like force. The nature of this damage led to an investigation of the possibility that the system might have contained material other than Freon. It was learned that the filler fitting for the aircraft Freon system mated only with the filler fitting on the Freon supply source so that the fitting on the supply source of any other material, such as oxygen, etc., would not fit. The possibility, under consideration, was therefore remote. A specific cause was indeterminable.

The fire shield separating zones 1 and 2 was intact and showed no evidence of in-flight fire. In zone 2, however, fire damage was found to the engine breather, vacuum suction, vacuum exhaust, and fuel suction lines. In an area below and close to the vacuum pump these lines were open to the atmosphere. The vacuum pump contained pieces of molten aluminum, some of which seized the pump causing the drive shaft to shear at the shear section. Because the pump is engine driven it is evident that in-flight fire existed which melted the metal that was drawn into the pump before the engine was stopped.

Zone 3 is constructed mainly of stainless steel except for the wheel well doors and its aft portion. Within the zone most lines are stainless steel except the aluminum alloy vacuum lines and a fire-resistant flexible hydraulic pressure line. Examination showed the zone was exposed to fire and major portions of the aluminum alloy and fire-resistant flexible lines were burned away. The stainless steel lines were intact.

The magnesium wheels, which were retracted into zone 3 during part of the flight and while in-flight fire existed, showed evidence of heat but were not burned. The gear strut piston and brakes showed no evidence of excessive heat or fire damage although the tires were fire damaged to a minor extent. Two small flexible lines, one located on the outer side of each brake, were burned through.

The front left and right wheel well doors were melted away except for a considerable portion of the leading edge and lower area of the right door and a similar portion of the leading edge and hinge area of the left door. Examination of the right door remaining structure showed that molten aluminum moving rearward had impinged in layers on the front surface of a vertical member of the right front door located about opposite the auxiliary fire shield that divides zones 3 and 3-A. A study of the photograph of the aircraft during the landing roll indicated that the lower center portion of the right front wheel well door was burned away although the fire at this time was pouring from the nacelle well behind the door.



Lockheed RC-130 Modified for Mapping

Lockheed RC-130 Hercules, modified on under-fuselage for photographic mapping mission, has been tested for nine months over Arizona, California, Georgia and Florida. Maps gained during the flights showed error of less than 1 ft. in 8 mi. Camera window is 42 in. in diameter.

There were three areas of molten aluminum spatterings on the zone 3 side of the auxiliary fire shield. These areas were the right center of the fire shield, the angled right edge of the fire shield pan covering the gear up-lock, and the angled left edge of the cutout in the fire shield for the main gear strut when the gear is retracted. There was no splattering found on the fire shield plate located on the gear strut which covers the cutout when the gear is up although a little was found on the strut, brake housing, and the wheels and tires of the right main gear.

Forward Damage

The most forward damage in zone 3-A was in the narrow area between the auxiliary fire shield rearward to the front wing spar and adjacent to the aforementioned cutout in the auxiliary fire shield. Here aluminum lines and fittings were melted away and the spar web and an area of heavy aluminum alloy wing surface below it were melted through. Directly aft of the cutout the stainless steel hydraulic extension and retraction lines for the gear showed evidence of intensive heat and the aluminum alloy "B" nut on the retracting line was split. A number of hydraulic lines and fittings of the system were burned through and a "B" nut of a landing gear down line, located on the front face of the front spar was melted.

The number 3 and 4 engine fuel lines in the area aft and somewhat higher than the top of the fireshield cutout were burned away allowing the associated fuel filters and fuel tank selector valves to fall free. Of these, the No. 3 filter fell free before the aircraft stopped; the others were found on the ground below their normal positions. Except for the No. 3 selector valve, which was closed, the others were fully or partially open. The emergency fuel shutoff valve, located in zone 3-A, was found in the open position as were the hydraulic and oil valves associated with the emergency shutoff system.

The large aluminum alloy fuel crossover line which connects the right fuel tanks through zone 3-A was distorted by heat and the rubber hose connection at the right end was disconnected by fire damage. Obviously this damage and that to the hydraulic and other fuel lines would release large quantities of flammable fluids into the fire.

In the aft part of zone 3-A the heavy aluminum alloy fitting located at the right end of the landing gear trunnion fitting received such intense heat that the bearing pulled out and fell to the ground before the aircraft stopped. This permitted the right main gear to collapse rearward.

Other than hinges, only small fragments were found of the left and right wheel well doors which normally close zone 3-A. One hinge was found on the landing runway and the others were found on the ground below their normal positions. All evidence indicated the rest of the door structure had melted away.

Because of the considerable probative evidence (most of which has already been described), found during the investigation of this accident, the investigators were acutely aware of the possibility that an abnormal exhaust flame may have occurred in conjunction with the engine failure. It was further thought that this flame then entered the nacelle igniting flammables causing the fire. This possibility was therefore pursued during the public hearing in which the Board sought technical information and experience data from highly qualified personnel of the engine manufacturer, Curtiss-Wright Corp.; the airframe manufacturer, Lockheed Aircraft Corp.; and the operator, Eastern Air Lines. This possibility was also discussed by a highly recognized and experienced witness in the field of flammables and conditions under which flammables can be ignited in flight.

In essence, it was the testimony of the representative of the engine manufacturer that during an engine failure of the nature that occurred it would be reasonable to expect some engine oil to be forced by case pressure into the exhaust system and into the airstream from the engine breather exits, located about 6 in. below, 8 in. inboard, and 8 in. behind the Nos. 1 and 2 exhaust exits. The amount of oil, he said, would depend upon the internal condition of the engine during failure and the

nature of the failure. For example, if pistons were torn out of their cylinders, oil could freely pass into the cylinders through the exhaust valves and into the exhaust system. Similarly, increased case pressure would result in oil and oil vapor being forced into the atmosphere through the engine breather exits. Obviously, both situations could occur simultaneously. The witness stated that excepting one or both situations he would not expect an exhaust flame which could ignite flammables in the interior of the nacelle. He emphasized this by stating there are literally hundreds of case histories of oil being forced into the exhaust and from the breather by combustion chamber failures, oil-locked pumps, and a variety of other engine troubles but there was no case, excepting the one under study, where a nacelle fire occurred during such difficulty. He concluded that, in his opinion, another element must have been present to cause the fire. Such element could be a leak in the nacelle.

To determine and show the effect of oil forced into the exhaust system, the Curtiss-Wright Corp. ran tests for the Board. Conducted in a test cell, the tests were made by injecting oil at controlled flow rates into the front exhaust extension of the No. 12 cylinder of an engine operating at METO power. Color motion pictures were taken of the exhaust flame as increasing amounts of oil were forced into the exhaust system. The pictures showed that with a small amount of oil the flame from the PRT became a dirty orange-red color. The flame, however, did not broaden or lengthen appreciably. As the flow rate was increased the flame diminished as the mixture obviously became too rich to burn. At this time a dense grey-white smoke appeared in place of the flame.

The Lockheed Aircraft Corp. representative, a powerplant staff engineer, testified that it was a regulatory requirement for the airframe manufacturer to determine that an exhaust flame does not enter an area, such as the wheel well, where flammables could be ignited and to determine that flammables do not enter the interior of the nacelle in hazardous quantities. The witness said that both determinations in the instance of the L-1049 were made from experience with earlier Constellations and by wind-tunnel tests which demonstrate the air flow patterns in and around the nacelle. He said the tests showed the exhaust flame would not enter the No. 3 nacelle or impinge the wheel well doors. He described the flow of the exhaust flame as being rearward and bending sharply upward away from the wheel well opening. He stated that with the wheel well doors open the airflow below the exhaust pattern would enter the interior of the No. 3 nacelle. He said the airflow is rearward against the auxiliary fire shield where it deflects upward to the top of zone 3. The flow is then forward along the top of the zone to the fire wall where it deflects downward and out of the nacelle. The witness said that during takeoff he would expect a turbulent airflow as a result of the ground effect, propeller blast, and the wheel well door being open at this time.

The witness stated that the engine breather location is a compromise of several considerations and because of this some engine oil does enter the No. 3 nacelle interior. This is most evident upon examination of the interior of the nacelle.

Discussing the possibility that the exhaust flame entered the nacelle or ignited a discharge of oil from the oil breather, the witness said that tests indicated the exhaust and nacelle skin temperature decreased sharply in the area of the wheel well. To him it seemed impossible to ignite flammables in the wheel well by an exhaust flame. He stated, however, he could not rule out the possibility that oil flowing out of the breather and streaking the nacelle was somehow ignited and entered the nacelle, or that a leak in the nacelle existed and was somehow ignited. The witness said that case histories showed only one zone 3 fire on the L-1049 series aircraft and this was determined to have been caused by an overheated brake which ignited flammables in zone 3 when, after takeoff, it was retracted into the zone.

The expert witness in the field of aircraft fires stated that he would not expect an extensive and sustaining flame from the PRT as the result of engine oil being introduced into the asembly. He said that without something for the flame to stick to or adhere to both the flame and flammable would blow away in the slipstream before much of a flame could develop. He indicated, however, that in such circumstance flecks of flame could be expected. For the same reasons he said a sustaining flame would not be expected on a smooth surface in the slipstream even though the surface was being continuously smeared with a flammable fluid.

Improbable Possibility

In considering the possibility of a hot exhaust stream contacting and igniting a stream of hot engine oil from the breather exit in the airstream, the witness stated this was possible but not probable. He said the improbability was because of the inherent difficulty of igniting a flammable in the slipstream, the stratification which tends to keep the two streams apart, and, in such circumstances, the lack of something to which the flame could adhere. The witness indicated that his statement was qualified because a stream of hot exhaust gases can ignite a stream of flammables if the streams can make contact. Considering the turbulent and disrupted airflow created by the propeller swirl and by the wheel well doors being open, such contact could occur. Further, if ignited the flame could develop and be sustained if it attached to the breather exit. Assuming such conditions, an oil-fed fire would be capable of burning through aluminum skin structure in about 20 sec. or even less if the structure was heated on both sides. Because of the improbability of the aforestated conditions occurring, the witness seemed to believe that flecks of flame, as previously described in his testimony, entering the nacelle and igniting an existing leak of flammables in zone 3 or 3-A was a more plausible explanation for the fire.

Commenting on the observations of witnesses to the accident, this witness indicated that burning oil would produce a dirty orange-red flame and the gray-white smoke reported by some observers would indicate oil that was beginning to get hot.

An incident occurred Mar. 25, 1959, which is significant and has an important bearing on this accident. It involved Flight 134, an Eastern Air Lines Constellation and a model which has identical engine and nacelle installations to N 6240G. Shortly after takeoff, Flight 134 experienced a failure of the No. 2 engine which, upon examination, showed nearly identical internal damage to the engine involved in the accident under consideration, except the damage involved the rear row of the power section instead of the front row.

A CAB investigator who witnessed this incident stated that after the engine was shut down and the propeller feathered, he observed a flame which emanated in the area of the exhaust and breather exits and trailed rearward at least to the trailing edge of the wing and continued to burn for nearly a minute while the flight made a pattern around the airport (Miami International) to land.

Examination of the front and rear outboard wheel well doors revealed heat damage coincident with the exhaust stains on the doors. Heat blisters and heat damage existed on the outside surface of the front door, and oil coating and charring was found on the leading edge of this door. Similar coking was found on the inside of the rear door in the area adjacent to the opening between the front and rear doors. The seal between the doors was undamaged. Examination also disclosed that the entire outside surface of the fire damaged doors was coated with engine oil and there was an abnormal accumulation of oil on the inside of the doors. Further, oil was dripping from the No. 1 PRT and the breather exit on the same side.

Examinations of the engine in this incident revealed no leaks and there was no release of exhaust flame and gases except through the normal exhaust system exits. It was evident that an exhaust flame during the type failure involved did impinge against the wheel well doors. The incident also proved that such exhaust flame can and did enter the nacelle between the front and rear doors with sufficient heat to coke oil deposits on the inside of the rear door as far rearward as a point just aft of the leading edge.

Analysis of the damage and damage patterns found in the No. 3 engine strongly indicates that the initial failure was a connecting rod, most probably No. 10. Failure of a connecting rod and/or the front main bearing could produce all of the engine damage that occurred; however, it is believed only a connecting rod failure could have produced this damage in the sequence indicated. Because the No. 10 rod showed a splitting-type failure while all others showed clean overload breaks, it is logical to believe that this rod failed first.

Failure of the No. 10 rod would undoubtedly add reciprocating loads on the front master rod; therefore, it most likely failed next. Similarly, with one or more rod failures the remaining pistons would begin to overtravel permitting the bottom rings to pass below the cylinder skirts progressively failing the piston rings, pistons, and connecting rods as indicated by damage found. Obviously, the unbalanced loads would produce flaring of the master rod until it failed. During the flaring, which was clearly shown on the front master rod, cocking of

the connecting rods and pistons could take place which would reasonably account for the heavy wear patterns found on the top land of one side of the pistons and on the piston skirt on the opposite side.

Initial failure of the connecting rod was also evident by the damage to the front main bearing itself. All of the failures in the bearing assembly were overloads as the result of jamming and restricting the normal bearing function. The only parts and pieces which would have jammed the bearing were those found in the assembly and these were from the front row pistons, connecting rods, and rings. In addition to this evidence, parts of the bearing found in the oil sumps were free of the heat indications that are normally characteristic of a bearing failure. Finally, had bearing failure been the initial occurrence, damage should have been found to the center and rear main bearings as well as to the reciprocating assemblies of the rear row; none was found. For these reasons the Board is of the opinion that failure of a connecting rod, probably No. 10, caused the engine failure.

It may be recalled that the flight crew experienced the engine failure shortly after takeoff and thereafter was confronted with an uncontrollable fire in the same nacelle. After a careful study of all the available evidence the Board is of the view the two occurrences were related and cannot be accepted as two isolated events that happened at nearly the same time in the same nacelle. Furthermore, there was no evidence found which could account for the fire having been started from a source of ignition within the nacelle.

Fire Source

It is therefore believed that the fire resulted from conditions and events relating to the engine failure. More specifically, within this area of consideration, there was no physical evidence found to show that the source of ignition came from zones 1 and 2 or from within the nacelle. Thus, it is firmly believed the ignition source for the nacelle fire must have been an abnormal exhaust which ignited a flammable substance outside of the nacelle. The resulting flame penetrated the nacelle through the aluminum wheel well doors. Substantial physical evidence, as well as some expert testimony, was available to support this opinion.

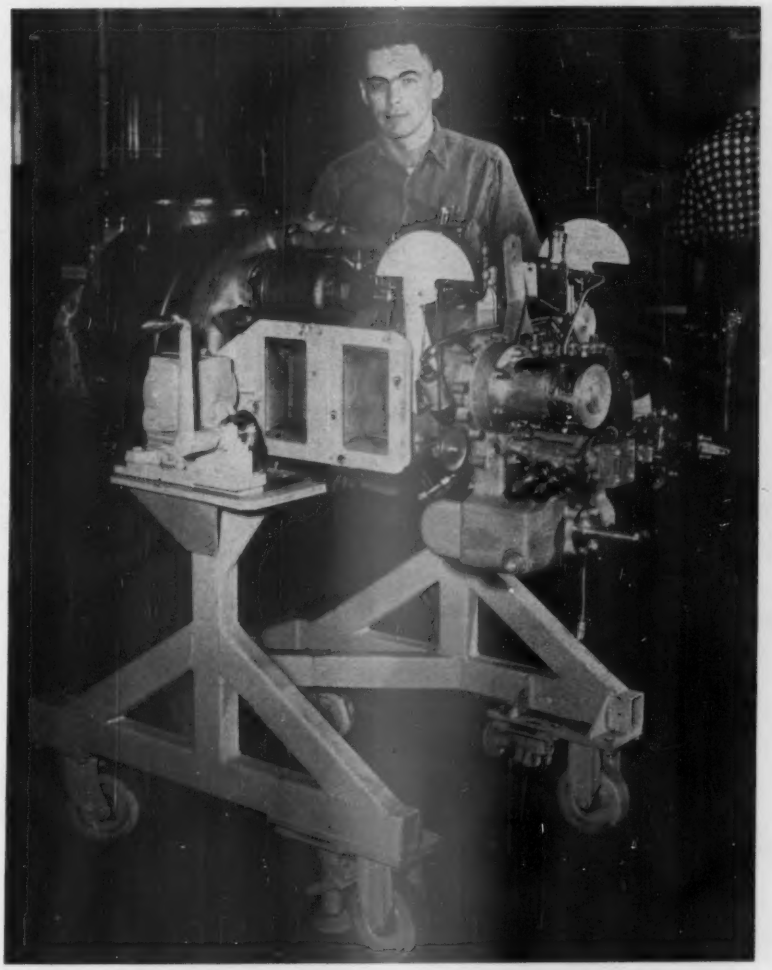
During an engine failure of the nature just described, hot, highly agitated engine oil and oil vapors would be forced into the airstream through the exhaust system and from the engine breathers. Even more so in this instance because two lower pistons had failed in a manner allowing them to fall into the crankcase where they had tumbled for some time as evidenced by the fact they were pounded into balls. This circumstance would permit crankcase oil to drain freely into the lower exhaust system. Similarly, from back pressure, oil and oil vapors would be forced from the crankcase breathers. In addition, as long as the engine controls remained at rated power, high airflow and fuel flow would be delivered to all combustion chambers since both cam drive assemblies were intact and operating. Although many of the front row pistons became incapable of compressing the mixture, it was free to pass into the exhaust and also to enter the crankcase and then into the slipstream through the engine breathers. This process probably began during the takeoff roll, as evidenced by the unusual gray-white smoke observed at this time. It would also continue and increase with the engine failure progression until the reciprocating action of the engine was stopped which, according to many eyewitnesses, was well after a major fire existed in the nacelle.

Although the tests conducted by Curtiss-Wright indicated that the introduction of oil into the exhaust system would not produce an abnormal flame, the Mar. 25 incident and verbal pilot reports prove conclusively that under certain circumstances an abnormal flame will occur. In this incident, under similar conditions of engine failure, an abnormal flame occurred and extended rearward under the wing to the trailing edge.

Investigation of the incident showed serious flame impingement on the wheel well doors, inside and outside, as far aft as the separation area between the front and rear sections. Furthermore, the flame continued for a period long after the engine was stopped and the exhaust source of flammable had discontinued. Again, compared with the tests, some differences were present in the incident. These, the Board believes, may have been the introduction of a fuel-air mixture, the slipstream effect not present in the tests, and the ignition of such a combustible mixture from the engine breather. Because more pistons were out of the cylinders in the accident situation, an even more combustible fuel-air mixture would have been present.

Exhaust Angle

It also appears significant that the No. 1 PRT exhaust is angled downward slightly with the opening just outboard, forward, and above the outboard breather. Also, examination of the oil breather pattern and exhaust stain shows they cross at the forward edge of the right front door. Thus, after consideration of all the aforestated conditions, the Board is of the opinion that although ignition of the breather mixture is not probable, under certain conditions, it is



Assembly Stand Developed for Turbine Engine

Boeing Airplane Co.'s 520 series lightweight gas turbine engine (AW July 20, p. 97) is secured in this engine assembly stand, developed by the company's Industrial Products Division. Assembly begins with two turbine inlet housings bolted to the stand. Engine can be turned by a crank which operates a 60-to-1 ratio worm gear.

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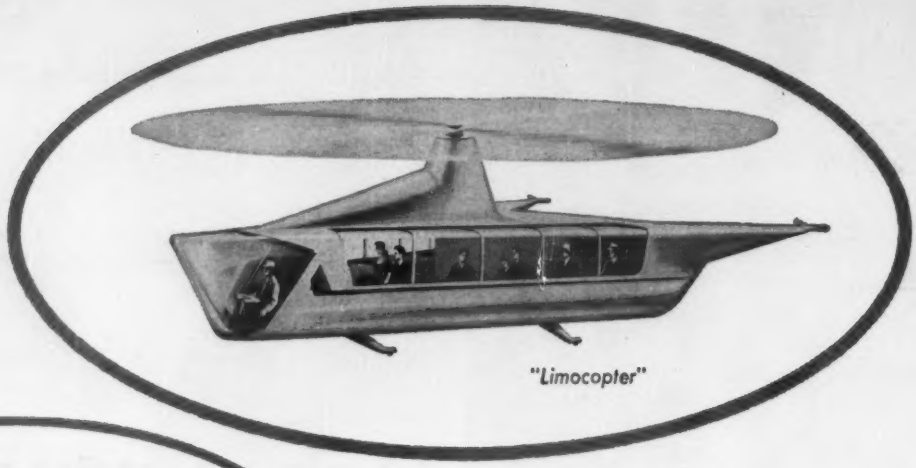

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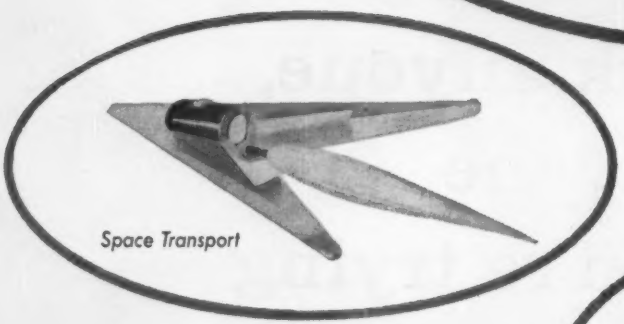

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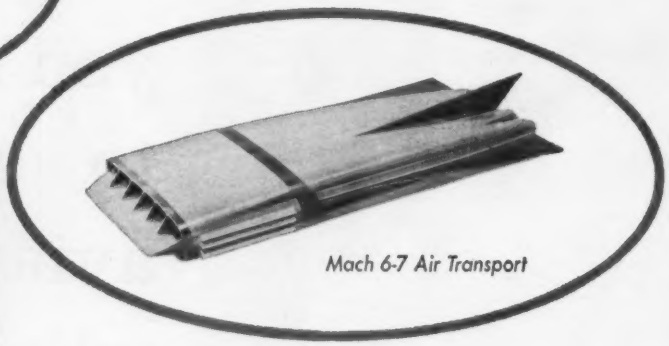

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possible that it did occur in this accident.

Because the normal discharge of breather oil enters the nacelle in considerable amounts it is most reasonable to believe a flame from the same source would enter the interior of the nacelle while the wheel well doors were open. Also, it is believed that such flame would impinge the doors while they were closed and, if of sufficient intensity, could burn through the aluminum structure in a few seconds. Considerable probative evidence exists leading the Board to believe the latter occurred in this instance.

This opinion is supported by the layered pattern of nonferrous metal which was impinged rearward and inward on the vertical outboard forward door member.

This could have occurred only in flight by a fire source outside the nacelle which burned through the aluminum doors to supply the molten metal. Although other metal splatter patterns found in zone 3 of the nacelle were in accordance with the in-flight swirl patterns with the wheel well doors open, it is believed such a pattern would exist with portions of the doors burned away. Further supporting the opinion that the doors were closed is the fact that fire warnings did not occur until well after gear retraction when the gear doors would have been closed.

Finally, the photograph of the aircraft during the landing roll showed a major portion of the right front door burned away although the existing fire at that time was well behind this area. Again, this burnout, together with the impingement pattern of molten aluminum, must have been caused by a sustained flame which originated outside the nacelle earlier in the sequence of events.

Thus, by this evidence and the elimination of other fire sources, the Board is of the opinion the source of the fire must have been the ignition of breather discharge which then burned through the wheel well doors.

Flame Penetration

It is also apparent that the flame penetrated zones 3 and 3-A before the engine was stopped. This is evident by the ingestion of molten metal by the engine-driven vacuum pump. It is considered probable that rotation of the propeller occurred or continued after the vacuum line, which supplied the metal, was melted. With such propeller rotation a continuation of the supply of flammables from the exhaust and PRT would exist for a longer period of time.

Even after the fire was extinguished the lines in zone 3 were intact; therefore, there could have been no continuing source of flammables in this zone which could have sustained a fire of the magnitude that occurred.

Relatively light damage in zone 3 also indicates this. In view of this evidence and because there was no way for the fire to enter zone 3-A from zone 3 with the gear up and the fire shield intact, the major fire must have been ignited in zone 3-A. It is considered most probable, therefore, that the breather flame, after burning through the wheel well doors, entered zone 3-A traveling upward and forward behind the auxiliary fire shield to the area of several flammable fluid-carrying lines and the No. 3 fuel filter.

Because of the extensive burnout that occurred in zone 3-A it is extremely difficult, if not impossible, to determine the precise source of flammable material where the uncontrollable fire began or if a pre-existing leak was present in the zone which, when ignited, sustained the flame until fire damage released the large quantities of flammable fluids. From the fire pattern and apparent airflow it is possible that the breather flame impinged the previously described heat-split B nut, creating a spray of hydraulic fluid, and/or impinged upon the light aluminum alloy cover of the No. 3 fuel filter creating a spray of fuel. Considering the fire-resistant quality of the lines in zone 3-A, the rapidity with which the fire began, and the lack of precedence for such fire, the Board cannot discount the possibility of a pre-existing leak.

Believing the raging fire was principally in zone 3-A, it is immediately apparent that because this zone is not serviced with fire extinguishing agent outlets, the fire could not be put out when the crew discharged the Freon. Also, since the source of the flammable which ignited is unknown, the effect of the flight engineer's failure to actuate the emergency fire-wall shutoff valve cannot be determined.

CONCLUSIONS

On the basis of all the available evidence the Board concludes that in this instance during an engine failure an abnormal exhaust flame occurred. It is concluded that this flame did, in fact, ignite an abnormal discharge of oil and fuel vapors from the outboard No. 3 engine breather exit. The resulting flame from the breather then impinged upon and burned through the right wheel well doors and entered the interior of the No. 3 nacelle. The Board concludes that although fire damage occurred in zone 3, the principal fire in the nacelle was ignited from a source of flammables in zone 3-A although the precise source and conditions surrounding how the flammables were released cannot be determined.

As a result of the accident the Board has submitted recommendations to the Federal Aviation Agency stating that it is believed necessary, in the interest of safety, that consideration be given to a requirement that zone 3-A of Constellation aircraft be serviced with fire-detection and fire extinguishing equipment. Also, that action is necessary which will, through directional control of the exhaust flame, ensure that an abnormal exhaust flame will not ignite a breather discharge or impinge upon the wheel well doors when they are either open or closed.

With respect to the airport rescue and firefighting activities, it is the Board's conclusion that a lack of equipment and equipment capability was the principal reason the aircraft fire was not extinguished more promptly. The record shows that the Airport Authority initiated action to increase its firefighting capability through procurement of new equipment.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was an uncontrollable fire ignited in zone 3-A by a burning breather discharge which was ignited by and

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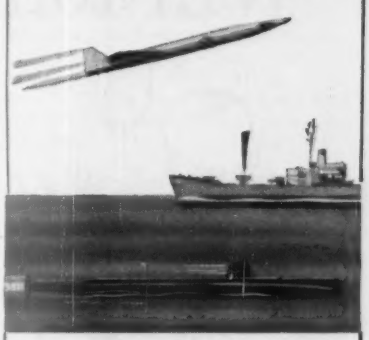

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combined with an abnormal exhaust flame during engine failure.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti
Louis J. Hector

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of this accident shortly after it occurred. An investigation was commenced in accordance with the provisions of Section 701 (a) (2) of the Federal Aviation Act of 1958. A public hearing was held in Miami Beach, Fla., on Mar. 31 and Apr. 1 and 2, 1959.

Eastern Air Lines, Inc., is a Delaware corporation with corporate offices in New York City. The air carrier is engaged in the transportation of persons, property, and mail by virtue of current certificates of public convenience and necessity isued by the Civil Aeronautics Board. It possesses an air carrier operating certificate issued by the Federal Aviation Agency for various routes.

Capt. James W. Rush, age 43, was employed by Eastern Air Lines Sept. 2, 1942, and became captain in 1944. He held a currently valid airman certificate with airplane transport rating and aircraft ratings on DC-3, Martin 202/404, DC 6/7, Lockheed Constellation and L-188. His last line check was Dec. 10, 1958. Capt. Rush held a current medical certificate, without waivers. At the time of the accident he had a total flying time of 15,984 hr. of which 2,919 were in the Constellation equipment.

Pilot Robert P. Harkless, age 36, was employed by Eastern Air Lines Jan. 31, 1955. He held a valid airman certificate with airline transport rating and ratings for Martin 202/404. He was checked out as first officer on L-1049G equipment Aug. 23, 1956. His last instrument check was satisfactorily accomplished Jan. 7, 1959, and he held a current medical certificate, without waivers. At the time of the accident Pilot Harkless had a total flying time of 6,800 hr., of which 1,974 were in Constellation equipment.

Flight Engineer Russel E. Eshbach, age 33, was employed by the company on Feb. 8, 1955, and became a qualified flight engineer Mar. 1, 1955. He held a valid airman certificate with flight engineer rating and aircraft and powerplant mechanic ratings. His medical certificate was current. He had completed his last line check Aug. 26, 1958, and his last proficiency check Dec. 10, 1958. Flight Engineer Eshbach had a total flying time of 2,217 hr., of which 1,087 were in Constellation equipment.

Flight Attendant Wanda Carr, age 23, was employed Nov. 5, 1956, and became a qualified flight attendant for Eastern Air Lines Dec. 8, 1956. Her last refresher emergency training was July 20, 1956.

Flight Attendant Esther Tharpe, age 30, was employed Jan. 9, 1952, and became a qualified flight attendant Feb. 15, 1952. Her last refresher emergency training was Oct. 2, 1958.

N 6240G, a Lockheed 1049G, manufacturer's serial number 4665, was acquired by Eastern Air Lines, new, Dec. 8, 1956. At the time of the accident the aircraft had accumulated 7,309 flying hours, of which 116 were since the last maintenance phase check on Nov. 24, 1958. The aircraft was powered by Wright engines, model 988TC-18EA-3, and Hamilton Standard propellers, model 43E60, blade model 6303B. The No. 3 engine had a total time of 5,579 hr., of which 19 hr. were since last overhaul.

FAA Revises Pilots' Instrument Needs

Washington—Commercial pilots now must have a minimum of 10 hr. of instrument flight instruction, under new requirements issued by Federal Aviation Agency in an amendment to Part 20 of Civil Air Regulations.

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In another amendment, private pilots now will be required to have dual instruction in basic control of aircraft by use of instruments and must demonstrate emergency manual capability in attitude control, simulating the loss of visual reference during flight. Both commercial and private pilots must demonstrate familiarity with radio for communications and navigation.

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WHO'S WHERE

(*Continued from page 23*)

Changes

Lester R. Grohe, chief engineer for components, American-Standard's Military Products Division, Norwood, Mass., succeeding **Edward L. Swainson** who has been appointed technical assistant to the president of the division.

Morris Lebovits, chief of astro-aero sciences, Solar Aircraft Co., San Diego, Calif. Also: **Ben C. Axley, Jr.,** chief of avionics, Solar's Research and Development Engineering Division.

Dr. William G. Hoover, technical director, Granger Associates, Palo Alto, Calif.

Willard H. Hughes, general manager, Microwave Division, Kearfott Co., Inc., Van Nuys, Calif., a subsidiary of General Precision Equipment Corp.

John L. Heins, head of engineering for GB Electronics Division of General Bronze Corp., Valley Stream, N. Y.

The Marquardt Corp.'s Nuclear Systems Division, Van Nuys, Calif., has made the following appointments: **Dr. John J. Wagner,** staff scientist; **Milton M. Weintraub,** manager, Controls Engineering Department.

Alexander N. Beichek, assistant director, the W. L. Maxson Corp.'s Research Laboratory, New York, N. Y.

Thomas F. Copeland, director of flying training, Flight Department, American Airlines, Inc.

Marvin J. Kahn, director of the newly organized Plans & Programs Division of Aircraft Armaments, Inc., Cockeysville, Md.

Charles E. McGee, director of news, and **Herbert A. Richardson,** director of publications, Trans World Airlines, Inc.

Dan McCarthy, general manager-airline operations, Transocean Air Lines.

Weber deVore, director of the newly organized Advanced Materials Division, Taylor Fibre Co., Norristown, Pa.

Philip H. Young, assistant chief engineer, Space Recovery Systems, Inc., El Segundo, Calif.

Dr. Vergil L. Saine, director of solid propellant operations, Ordill plant of Olin Mathieson Chemical Corp., Marion, Ill.

Leslie G. Carter, operations manager, New York Airways, Inc. **Capt. Frank LoTurco** succeeds Mr. Carter as chief pilot. Also: **Capt. Edwin N. Baur,** assistant chief pilot.

Benjamin F. Rose, Jr., manager of the newly formed Aetron Division, Covina, Calif., of Aerojet-General Corp.

George J. Vila, Washington, D. C., manager-NASA for Convair Division of General Dynamics Corp. **Thomas G. Pownall** succeeds Mr. Vila as Washington representative for Convair (Astronautics).

James S. Farrior, Polaris missile system guidance manager, Lockheed Missiles and Space Division, Sunnyvale, Calif., succeeding **A. F. Blight** who becomes Polaris internal systems manager.

S. Austin Van Houten, manager of production and material control, Hughes Aircraft Co.'s Ground Systems Group, Fullerton, Calif. Also: **John C. Morey,** manager of quality assurance for the Ground Systems Group.

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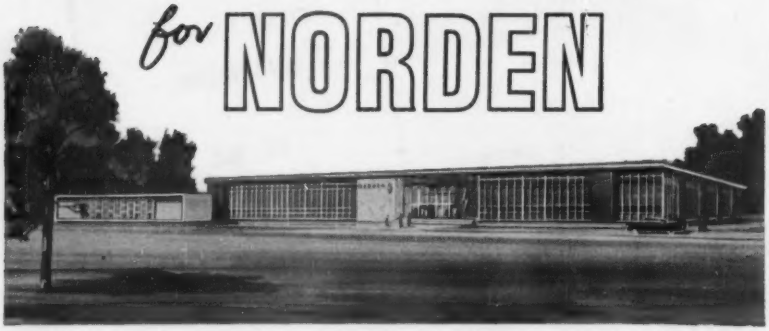

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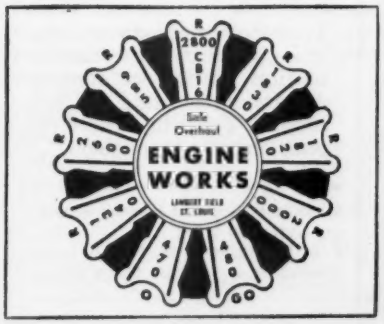

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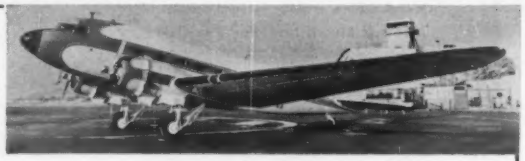

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LETTERS

Linguistic Incongruity

In reply to Mr. Fulford's letter "Word Choice," in the Oct. 26 issue, p. 154: I believe if he looked up Civil Air Regulation 60-60 it would satisfy his questioning your choice of words.

As a definition CAR 60-60 states: "Acrobatic Flight Maneuvers intentionally performed by an aircraft involving an abrupt change in its altitude, an abnormal attitude, or an abnormal acceleration."

Very few pilots I know use the term acrobatics in their discussions on flying. It seems to me the interchange of words here is just another example of the incongruities of the English language. Agreed?

1st/Lt. James H. Beasley
USAF
Wethersfield, England

Defense Dollars

"Washington, Nov. 6—The Navy is scrapping 14 SeaMaster jet seaplanes built by the Martin Co. under a $441,000,000 contract terminated last August.

"A Navy spokesman said usable parts and instruments will be removed before the hulks are scrapped.

"The program was scrapped in August in an effort to save $72 million in proposed expenditures for the planes and support equipment."

The above news release appeared in the Oakland Tribune, Nov. 5, 1959. Most people who are not concerned with the defense of this country probably took it for granted or ignored it. But let us look at the sordid record of the Navy Department in matters of procurement. Certainly the taxpayer under the compulsion of law to pay for these enormous expenditures is entitled to something more in the way of defense of his homeland. Let us look at the record during the past several years:

(1) The Navy jet engine plant at Romulus, Mich., project. About $50 million.

(2) The McDonnell F3H-1 fiasco. Millions, wasted, running into the hundreds, for planes that had to be scrapped due to improper procurement policies by Navy procurement officials. Lives lost.

(3) The Convair R3Y Flying Boats that had to be mothballed due to the insistence of the Navy that contrarotating propeller powerplants be used. These planes are idle after two were wrecked. This project: $220 million.

(4) The SeaMaster program scrapped in its entirety because the Navy insisted on invading the orbit of operations performed by the Strategic Air Command. Four hundred forty-one million dollars wasted and lives lost. Why a 600 mph. seaplane was facetiously labeled as a "minelayer" is more than credulous.

Now what does this add up to? For one thing it shows the procurement policy, apparently with the blessing of the Congress, is little thought of, regardless of the enormous waste to the taxpayer who is not getting the most out of the defense dollar. Yet the Administration has done nothing to correct this situation nor has it criticized naval procurement policies for the way they are now being conducted.

But this does something much more harmful than the mere wasting of dollars which the poor overburdened taxpayer must supply. It shows our potential enemy, Red Russia, that the top technical direction is confused and that interservice rivalry cannot be controlled by the top administration of our Defense Department. It also shows that, if a military showdown ever arrives, we are infected with confusion and waste. This Administration has done nothing to correct these disastrous policies. Waste is a luxury we cannot afford.

In round figures, the record reveals that approximately $1 billion were wasted, that many lives were lost in accidents, that we are not getting the most out of the available defense dollar, and that technical direction is inadequate to meet the demands of the day to defend this country. We think it is time for a change!

Willis L. Nye
Hayward, Calif.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Pilot's Pay Cut

Reference the Delta Air Lines pilot dispute over seniority (AW Nov. 2, p. 41), my eyes are filled with tears for that poor Delta pilot who, because of the seniority dispute, was forced to take a DC-7 schedule at near-starvation wage of only $22,140 a year instead of being able to board the DC-8 gravy train at $28,692.

If I only knew this poor pilot's name, I'd help raise a collection to feed his family (or pay for his new swimming pool). When are the airline pilots going to grow up and stop behaving like pigs at the trough?

Airline Passenger
4201 Massachusetts Ave., N. W.
Washington, D. C.

Space Apathy

Being a college student does not qualify me as an expert in astronautics or politics and I try not to make it a habit to display my ignorance in these subjects. But it does not take an expert to observe the inert form of complacency which still prevails in America in reference to Soviet space achievements.

I believe that this complacency stems from (1) a general disinterest of the American public other than a light curiosity in space achievement; (2) a false belief that U. S. achievements in space—the Explorers, Pioneers, and Discoverers—are at least equal in magnitude to the Russian Mechtas, Luniks, and Sputniks; (3) a tendency to belittle the magnitude of Soviet achievement with such statements as put forth by Mr. Claflin in his letter (AW Nov. 2, p. 134), "Should Russia get that much credit for missing the original target, the moon?" or, "Anyone can cluster engines, and with enough tries they will all bang off together."

This type of feeling extends all the way to some of the top level positions of Congress and the Administration. It is the real reason for all the ". . . confusion and disagreement as to exactly what we are trying to accomplish . . ."; not the negative potential of space flight as Mr. Claflin believes.

There must be some way to prod Congress and the Administration to formulate specific programs for such projects as a manned space station utilizing available or soon to be available hardware and boosters, and to back up such programs with adequate funding.

If we cannot find a way to overcome our inertia, the Russians will when they place the first man in space. I would certainly prefer the products of the "fear and other ugly emotions" that AW is trying to stir up to this.

James E. Huchingson
Melbourne, Fla.

Invisible Hazard

The Safety article in your Nov. 9 issue p. 133), in which it is shown that vortices trailing heavy aircraft for long distances can cause major structural failure of other aircraft, is most disturbing.

This highly dangerous, invisible hazard appears to have been isolated to airflow effects at wing tips. If so, why shouldn't this be the subject of research with the objective of removing or significantly reducing this hazard for the flying public?

It would seem possible that wing tip design could be modified to keep this effect within reasonable bounds in much the same way as efforts to reduce aircraft noise are being made. This sounds like a job for NASA or the AOPA Foundation, or both.

J. Kenneth Lewis
College Park, Md.

Same Name

In the Oct. 12 issue of Aviation Week, on p. 57, there is mention of a British missile called "Seacat."

We have read of it direct from British publications before, but didn't bother since it was over there.

Now that the name "Seacat" is published in the U.S.A., in your AW, we must mention that it is a registered trademark of ours.

On the other hand, what earthly connection can there be between a missile and a Seacat?

We have derived it from sea-going catamaran, a type of boat. We also note that the land version of their missile is to be called Tigercat. This is the trademark of an East Coast boatbuilder, applied again to a catamaran. Can't those British be original?

Dick Szakacs
Hydrocraft
San Diego, Calif.

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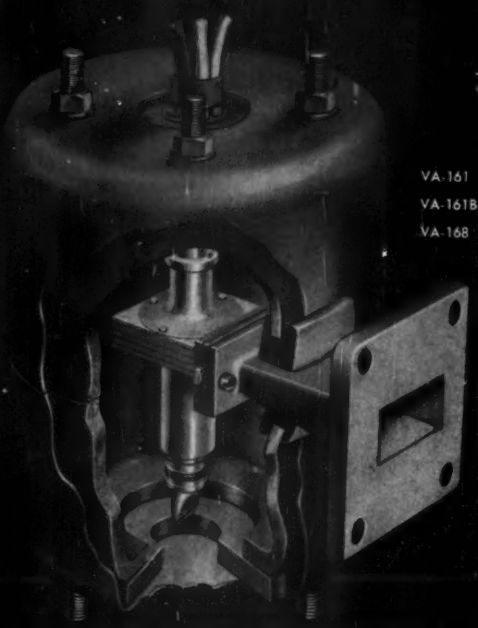

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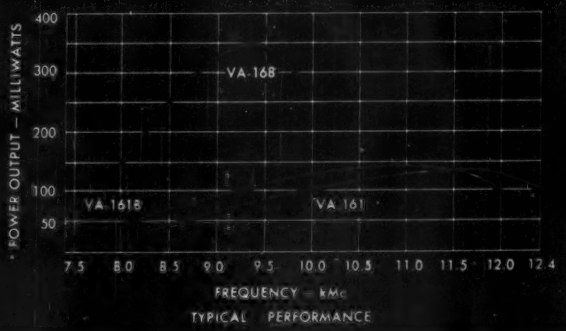

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